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2055

A MANUAL
OF
NATURAL HISTORY,
FOR
THE USE OF TRAVELLERS;
BEING A
DESCRIPTION OF THE FAMILIES
OF THE
ANIMAL AND VEGETABLE KINGDOMS:
WITH
REMARKS ON THE PRACTICAL STUDY OF GEOLOGY AND METEOROLOGY.

TO WHICH ARE APPENDED
Directions for Collecting and Preserving.

BY
ARTHUR ADAMS,
M.R.C.S.; F.L.S.; M.E.S., STETTIN;
WILLIAM BALFOUR BAIKIE, M.D.,
F.R.S.E.; LATE ONE OF THE PRESIDENTS OF THE ROYAL MEDICAL SOCIETY OF EDINBURGH.
AND
CHARLES BARRON,
Curator of the Royal Naval Museum at Haslar.

LONDON:
JOHN VAN VOORST, PATERNOSTER ROW.
MDCCCLIV.

6
A3

My Boyhood.

1857

Ah me! those joyous days are gone!
I little dreamt, till they were flown,
How fleeting were the hours!
For, lest he break the pleasing spell,
Time bears for youth a muffled bell,
And hides his face in flowers!

Ah! well I mind me of the days,
Still bright in memory's flattering rays
When all was fair and new;
When knaves were only found in books,
And friends were known by friendly looks,
And love was always true!

While yet of sin I scarcely dreamed,
And everything was what it seemed,
And all too bright for choice;
When fays were wont to guard my sleep,
And *Crusoe* still cou'd make me weep,
And *Santaclaus*, rejoice!

When heaven was pictured to my thought,
(In spite of all my mother taught
Of happiness serene)
A theatre of boyish plays—
One glorious round of holidays,
Without a school between!

Ah me! these joyous days are gone;
I little dreamt, till they were flown,
How fleeting were the hours!
For, lest he break the pleasing spell,
Time bears for youth a muffled bell,
And hides his face in flowers!—*John G. Saxe.*

Stop Thief!

1857

I saw a figure in my rear,
With stealthy step he ventured near
And snatched a curl away.
"Give back the ringlet, give," I cried,
"I need it a defect to hide"—
He gave, but it was *gray*.

Then with a cold and formal bow
He touched his pencil to my brow—
Ah, what a mark was there!
"Oh, wipe it off, you imp," I cried;
He left another by its side,
And mocked at my despair.

And then, as if to leave a trace
Of all his footprints on my face,
He stole the peach's bloom
Which mantled o'er my rosy cheek,
And left me sallow, pale and weak,
Fit tenant for the tomb.

He stole my merry heart so gay,
He stole my ringing laugh away,
He veiled my lustrous eye;
He stole my firm elastic step,
Stole all my charms, is stealing yet,
And will steal till I die.

"Stop thief! stop thief! stop thief!" I cried.
A gentle angel-voice replied,
"Weep not for faded flowers;
The arrant thief you so much fear,
Your beauties has replanted here.

63, SNOW HILL.

PREFACE.

THE design of the following pages is to endeavour to supply what seems to be a blank in the scientific literature of this country, for, although numerous treatises exist upon every branch, yet no work has hitherto appeared, comprising either succinctly or in detail, a comprehensive outline of Natural History. It may appear presumptuous on the part of the Authors to attempt to grapple with such an extensive range of subjects, which, they feel must be, in many instances, inadequately treated, still they trust that their effort to condense, within the limits of a portable volume, the leading features of Animate and Inanimate Nature, may prove of service to those at least for whom it is more especially intended. Their chief aim has been to render their work at once sufficiently popular for the general reader, without, at the same time, lessening its scientific value. For this purpose technicalities have been avoided whenever their employment could be dispensed with, English names have been given to all the Classes, Orders, and Families, and the principal divisions have been prefaced by brief introductory remarks. The classification adopted is that which has seemed most closely to accord with the advanced views of the time; and throughout the Animal and Vegetable Kingdoms a uniform system has been employed, so that similar subdivisions are designated by a cognate nomenclature.

January, 1854.

THE AURORA BOREALIS SEEN AT SACRAMENTO.—The *Aurora Borealis* was seen on the night of 16th December, about half-past 11 o'clock, at Sacramento. It is described as having been a beautiful exhibition, and is supposed to be the first that has been observed in this country since it became an American State. The *Union* remarks on the phenomenon: 185

To the observer on Second street, the *aurora* first appeared in a northeasterly direction, presenting every appearance of an extensive fire, and, therefore, creating a general alarm and turning out of the entire apparatus of the Fire Department. The phenomenon extended gradually and rapidly over the northern section of the heavens, the dominant hue being a beautiful crimson. Its duration was probably only about fifteen minutes; but during that time its aspect was frequently changed by the successive appearance and shifting of streaks or columns of white light, which seemed to be more conspicuous at either extreme of the arch.

SNOW FLEAS.—While perambulating over the deep snows, lying on the mountains everywhere around us, we have often observed myriads of small insects covering the surface in almost every direction. Our curiosity being excited, we have taken pains to examine them more minutely, and find them to be what we call (in the absence of another name) snow fleas. They closely resemble the regular flea, both as regards action and appearance, but are not over half the size. While watching them we have seen them burrow beneath the snow to the depth of an inch, and and reappear with all the sprightliness of the back biting tribe; so far as we have been able to learn; they derive their sustenance from the snow exclusively, never having observed them on any other substance. Can any one inform us more fully of the nature of these beasts?—*La Porte Messenger.* 1857

SHOOTING GAME WITH A PITCHFORK.—So dense was the fog Dec. 14th, says the Colusa *Advocate*, that wild geese became lost, and were seen whizzing about, very near the ground, and one flock of three struck the barn of the C. S. Co., at this place, and one of the birds was so stunned that it fell and was captured by the hostler, who happened to be standing by with a pitchfork in his hand. This mode of shooting birds is an improvement on the old plan of putting salt on their tails.

INTRODUCTION.

NATURAL History, or the study of the Mundane Creation, may be primarily divided into two grand empires, whose territories are distinct, and whose boundaries are well defined. The one is the Organic, or that of Animated Nature ; the other is the Inorganic, or Inanimate. The first of these, which comprises within its realms everything possessed of life on our planet, is sub-divided into two kingdoms, viz., the Animal or Zoological, and the Vegetable or Phytological. The domains of Inorganic Nature again comprehend Meteorology, or the science of atmospheric phenomena, and Geology, or the history of the composition of our globe, which includes Physical-Geography, or the superficial structure of the earth, and Mineralogy, or a knowledge of the component parts of rocks. A connecting link between these two great divisions is supplied by Palæontology, or the study of Fossil Remains, which, though now petrified and inanimate, were once living organisms, abundantly supplied with vitality. A thorough acquaintance with all these varied branches being almost impossible, the student of Nature must make a selection according to his predilections or his opportunities. But while occupied more intently with one subject, the others need not be entirely overlooked, and particularly when travelling facts and appearances may be recorded, and specimens collected which will serve to facilitate the studies of fellow-labourers in the same field.

The pursuit of Natural History, though adapted more or less to almost any locality, cannot be followed to more advantage, than by persons visiting distant countries or little-explored regions. The desirableness of collecting cannot be too strongly impressed upon travellers, as frequently with but little exertion on their part, much valuable information may be gleaned. To forward such views, the following work has been written, combining within portable bulk sufficient instruction on these diversified topics to point out to the reader what he ought to observe, and how he ought to preserve. And who can tell the result of well-directed exertions? Some "strange, bright bird" may, perhaps, on examination, serve to fill up an unoccupied space in the web of nature,—a fossil bone may possibly reveal the existence of some previously unknown, monstrous, pre-Adamite form,—a broken branch may disclose invaluable materials for future Navies,—a mineral fragment may indicate a yet untried gold region,—or a geological observation may point out a new locality for that indispensable aid to industry, coal. Of late years, Natural History, no longer a chaotic mass of wild theories or vague assertions, but a truly inductive science, has proved of vast service to commercial pursuits, and now possesses a truly national interest. Already the names of its cultivators occupy a proud position in the annals of fame, and with another generation they may rank, at least, as high as those of the warriors and heroes of past ages. Let the Zoologist, the Botanist, or the Geologist consider that their discoveries and labours will be remembered when deeds of blood are thought of no more; and, in the meantime, they may, with pleasure and satisfaction, reflect that they have made themselves known to the world, not by inflicting pain or misery on their fellows, but by working peaceably yet earnestly for their welfare; that those who venture into remote lands, or among savage tribes, in attempting to elucidate the laws of Nature, have as high a claim to distinction as the ruthless conqueror; and that those who devote their talents and their labours to furthering this great end, will secure for themselves an honourable position in the lasting records of science.

ERRATA.

Page	65,	line	20	for	25	read	28
,,	82	,,	31	,,	Skates	,,	Turbots
,,	273	,,	25	,,	Araneidæ	,,	Araneida
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,,	302	,,	23	,,	*Daracia*	,,	*Doracia*
,,	,,	,,	24	,,	*Conopea*	,,	*Conoplea*
,,	,,	,,	31	,,	*Asterolepas*	,,	*Astrolepas*
,,	346	,,	12	after	10	place	Family
,,	379	,,	27	for	*Cœlmintha*	read	*Cœlelmintha*
,,	432	,,	13	for	Cane-wood	read	Cam-wood
,,	446	,,	16	after	10	place	Family
,,	508	,,	10	,,	occuring	,,	occurring
,,	552	,,	6	,,	*Clymenidæ*	,,	*Clymeniidæ*
,,	567	,,	27	after	*Cycadaceæ*	place	a comma
,,	575	,,	20	for	Montmarle	read	Montmartre
,,	671	,,	5	,,	preparations	,,	preparation
,,	,,	,,	10	,,	minature	,,	miniature
,,	672	,,	18	omit	four-		
,,	712	,,		after	Dendrocœla	insert	Dendronotidæ ...141

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PART I.

ZOOLOGY.

THE NATURAL FAMILIES OF THE ANIMAL KINGDOM, ARRANGED ACCORDING TO THEIR ORGANIZATION.

THE ANIMAL KINGDOM.

In pursuing the study of the Animal Kingdom, two different methods may be followed. The one named the Zoological, considers more especially the classification and arrangement of living creatures from their external configuration and general shape; the other, by the aid of Comparative Anatomy, directs attention more particularly to their internal structure and physiological analogies. To obtain a complete acquaintance with the subject, both plans of research must be adopted, but by those whose time and opportunities are too limited for such a comprehensive study, either of these two branches may be followed out, without totally losing sight of the other. The latter is most successfully studied at home, while the former is of greater consequence to the travelling naturalist, for whose behoof this work is intended. In describing therefore the various classes, orders, and families, attention will be paid more particularly to external configuration, and the leading characteristics will be, as far as practicable, of a strictly *Zoological* nature; not that for a moment we would, by so doing, wish to cast any slight upon the other branch, which is undoubtedly the higher and more philosophical of the two, but merely because it is not of so practical a nature, nor so universally applicable for general discrimination of forms, and consequently less adapted for the purpose we have in view.

A succinct and exact definition of an animal, as distinguished from a vegetable, is not an easy task. The two kingdoms do not run into each other by any means, but both appear to spring from a common root, viz., *vitality;* and, for some distance from their origin, are so closely blended that a separation is extremely difficult. Accordingly we find that the lowest members of each group are, by different writers, described as animals, or as vegetables, just as their ideas happen to dictate. Linnæus on this point gave utterance to a celebrated axiom, viz., "Stones grow, vegetables grow and live, animals grow, live, and feel." This, though perhaps true enough in the main, is not sufficiently explicit, as it is difficult to prove that Sponges, which are generally admitted as animals, are possessed of feeling; while again Sir James Edward Smith argued, though quite on hypothetical grounds, that plants might be endowed with sensation, though in a very low degree, in which opinion, however, he had but few followers. The power of voluntary motion has also been brought forward as a test, but such a criterion is alike futile and inapplicable. Another distinguishing feature was believed to be afforded by burning the substance in question, when, if of an animal nature, it would give out an empyreumatic odour, because of its containing nitrogen; but it has since been shewn that this element is also afforded by vegetables. The most satisfactory definition yet advanced is, that "animals are possessed of an internal receptacle for food, wherein they collect the nutriment destined for their support."* Even this, however, is not fully correct. Another line of demarcation has been attempted to be drawn from the circumstance that animals obtain nutriment only from previously organized matter, while plants ar nourished by inorganic material, which they thus prepare for the ultimate support of animal life. Many, if not all of these hold good, and are quite applicable in reference to the more advanced forms of both kingdoms; but in their primary stages the question still remains to be solved. It has been beautifully observed by an eminent zoological authority, "Light and darkness are distinct from each other, and no one possessed of eye-sight would be in danger of confounding night with day; yet he who, looking upon the evening sky, would attempt to point out precisely the line of separation between the parting day and the approaching night, would have a difficult task to perform." And so it is with the point we have had under consideration. Nature throughout her works erects no lofty barriers, no visible boundaries; for however well marked the central portions of her various territories may seem, yet on their confines they are so closely united, so intimately combined, as to blend her entire domains into a perfect and harmonious whole.

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* *Vide* "Rymer Jones." Nat. Hist. of Animals.—Vol. I., p. 5.

The most simple division of the Animal Kingdom is into Vertebrates and Invertebrates, the latter being again divided into four sub-kingdoms. These are distributed into classes, orders, sub-orders, and families, which is the extent to which we shall trace them in the following pages; as an enquiry into sub-families, genera, sub-genera, and species, would be perfectly impracticable within the limits of a portable volume. The system of nomenclature adopted is as uniform as circumstances allow, especially in the case of the families, which, according to the prevalent zoological views of the day, are always indicated by ending in *idæ*.

CLASSIFICATION OF THE ANIMAL KINGDOM.

I.—SUB-KINGDOM. VERTEBRATE ANIMALS.

Vertebrata, *Cuv.* Spinicerebrata, Encephalata, *Grant.* Myelencephala, *Owen.*

1	Class	*Mammals*	(Mammalia, Mammifera)
2	„	*Birds*	(Aves)
3	„	*Reptiles*	(Reptilia)
4	„	*Amphibians*	(Amphibia)
5	„	*Fishes*	(Pisces)

II.—SUB-KINGDOM. MOLLUSCOUS ANIMALS.

Mollusca, *Cuv.* Cyclogangliata, *Grant.* Heterogangliata, *Owen.*

1	Class	*Cephalopods*	(Cephalopoda)
2	„	*Pteropods*	(Pteropoda)
3	„	*Gasteropods* (Univalves)	(Gasteropoda)
4	„	*Bivalves*	(Conchifera)
5	„	*Tunicaries*	(Tunicata)
6	„	*Brachiopods*	(Brachiopoda, Palliobranchiata)

III.—SUB-KINGDOM. ANNULOSE ANIMALS.

Articulata, *Cuv.* Annulosa, *Macleay.* Diplogangliata, Entomoida, Diploneura (part) *Grant.* Homogangliata, *Owen.*

1	Class	*Cirrhopods*	(Cirrhopoda, Cirripedes)
2	„	*Crustaceans*	(Crustacea)
3	„	*Fish-Parasites*	(Epizoa)
4	„	*Arachnidans*	(Arachnida)
5	„	*Insects*	(Insecta)
6	„	*Myriapods*	(Myriapoda)
7	„	*Annelids*	(Annelida, Annulida)

IV.—SUB-KINGDOM. RADIATE ANIMALS.

Radiata (part), *Cuv.* Diploneura vel Helminthoida (part), Cycloneura (part), *Grant.* Nematoneura, *Owen.* Zoophyta, *Auct.*

1	Class	*Echinoderms*	(Echinodermata)
2	„	*Wheel-Animalcules*	(Rotifera)
3	„	*Ascidian-Polyps*	(Polyzoa, Bryozoa)
4	„	*Cavitary-Entozoa*	(Cœlelmintha, Nematoidea)
5	„	*Parenchymatous-Entozoa*	(Sterelmintha)
6	„	*Sea-Nettles*	(Acalephæ, Malactinia)
7	„	*Polyps*	(Polypifera, Phytozoa)

V.—SUB-KINGDOM. ACRITE ANIMALS.

Acrita, *Macleay.* Cryptoneura (part) *Rudolphi.* Cycloneura (part), *Grant.* Oozoa, *Carus.* Protozoa, *Oken.*

1 Class *Polygastric-Animalcules* (Polygastrica, Infusoria)
2 „ *Foraminifers*...............(Foraminifera)
3 „ *Sponges* ....(Porifera, Amorphozoa)

SUB-KINGDOM OF VERTEBRATES.

The vertebrate animals constitute the first great division of the Animal Kingdom, and embrace the highest and most intelligent forms of living creatures, ascending from fishes, and finally arriving at man himself. The members composing this important group are very numerous, and are formed to inhabit the air, the earth, and the waters, different individuals being adapted for each element by their external configuration and internal structure. Among them are to be found the largest and most bulky of living forms, as the whale and elephant among mammals, the ostrich among birds, the reptilian crocodile, and the basking-shark—the giant of the finny tribes. In them the nervous centres are more specially allocated and protected by being placed in a bony canal; and the organs of special sense are most perfectly developed. The expansion of nervous matter forming the brain first commences in them, at first small and unimportant, but gradually increasing in size and volume until it finally appears in the human race in its most perfect condition. In the size, number, and complicated nature of most of their viscera the Vertebrates shew a great advance over the inferior classes; but on these points it would be out of place here to enlarge; suffice it to say, that the body is generally divisible into a head, a trunk, and extremities, the latter never exceeding four in number. The voluntary movements attain perfection, being less automatic and more the result of volition than among the lower orders; and the system of organic life, so developed in the mollusks, here gives way to the more important system of animal life. In short, taking a mollusk or a star-fish as examples of an Invertebrate, we find them to live within themselves and for themselves, not exactly worshipping their bellies, as they can hardly be said to possess one, yet devoted to gastronomy, in which they are probably adepts, and spending their time in alternate feeding and repose. While in Vertebrates higher occupations manifest themselves, sight, hearing, smell, taste, and touch become more refined, social feelings, of a different description from those of the ants and bees, are observed, passions of various kinds disturb the frame, until finally the whole are centred in talking, reasoning, busy, marrying man.

1.—SUB-KINGDOM OF VERTEBRATES.—*Vertebrata.*

Skeleton internal, jointed, vital, cartilaginous, or osseous. Head distinct, enclosing, and covering with the vertebræ the principal nervous centres.

Extremities never exceed four. Anal and oral orifices distinct, remote, mostly at opposite extremities. Organs of special sense well developed, chiefly situated in or near the face. Mouth with two jaws opening vertically, one situated either above or before the other; blood, red; heart, muscular; sexes, separated; generation, viviparous or oviparous.

MAMMALS.

Among the many and singular forms to be met with in this class, are numerous examples which alike puzzle the systematist and astonish the beholder; forms which clearly prove that though linear arrangements may be most convenient for our purposes, and such they certainly are with the present state of knowledge, they yet are naught but artificial. Some have thought circular arrangements to be the natural method; but all are found imperfect, unusual forms occurring, having so many apparent affinities, yet with such an amount of differences as to baffle the ingenuity of the most profound naturalists. A fit symbol of the arrangement of the Animal Kingdom in nature might perhaps be found in the beautiful web of the garden spider *(Epeira diadema)*.

The Mammalia are placed at the head of the Animal Kingdom, because in them are to be found the most complete development of faculties and the most advanced structure.

Man, regarded as an animal, stands first; having the most perfect form, the most delicate sensations, pre-eminent intelligence, and being little dependant on instinct. Those which follow are all found to be endowed with faculties and forms admirably suited to their modes of living, and to the vicissitudes to which they may be exposed. Those singular animals, the Bats—whose noiseless flight and rapid evolutions we witness in the summer evenings—may well arrest attention, as amongst the many examples affording proof of design and adaptation; nor, as we proceed, shall we be at a loss to find numerous others equally striking. The Mole, doomed to live a subterraneous life, and seek its food beneath the surface of the soil, requires suitable adaptations; these it has to perfection in its fore feet, so admirably formed for digging; the Hedgehog, not endowed with speed or strength to avoid a combat with an enemy, rolls itself up, and presents a prickly ball, which few dare touch, and as its food, chiefly consisting of coleopterous insects, is only to be found during the warmer seasons of the year, it passes the winter in a state of hybernation, instead of being subjected to the torture of a long fast. The Lion and Tiger, with the rest of the cat tribe, intended to live a rapacious life, possess great strength and agility, with teeth and claws of a most formidable nature; the latter, in order to preserve them with constant sharp points, are ordinarily kept in a retracted state, and are only thrust forward at the will of the animal, when about to seize its prey, or to act defensively; their habits too, being chiefly nocturnal, require appropriate organs of vision; thus we find the pupils of the eyes very large and susceptible, and that they may not be inconvenienced by the glare of day, the irides remain contracted during that time, leaving but a small part exposed. In the Seals, and more particularly in the Whales, we see the form modified, so as to be entirely adapted for an aquatic life. With the former it becomes necessary that they should at times seek the land or the ledges of rock for repose; their shape therefore has still some resemblance to the terrestrial members of the class to which they belong; while in the latter, destined to reside wholly in the water, the external form is fish-like, only, however, purely adaptive, as they still possess the essential character of mammals, having the organs of respiration and circulation so arranged as to enable them to dive down and remain for a limited period in the depths of the ocean. The Camel, intended to live on barren sandy tracts of dry and heated desert land, where other animals, without some special provision, would perish from thirst, are provided with the means of allaying theirs, by a peculiar modification of the stomach, which thus becomes a reservoir of water sufficient for many days' consumption; their feet, too, broad, padded, and elastic, are well suited for travelling over such light and yielding soil. The teeth of the Rodents furnish us with another instance. The front, or cutting teeth, by continually growing from a persistent pulp, compensate for the wear to which they are constantly subjected, and the inner part, being of a softer material than the outside ayer, a sharp edge is always preserved by their mutual attrition. The Sloth, destined to pass an arboreal life, and to feed on the foliage of trees, has its limbs modified into organs of suspension, and from their peculiar form and the position they hold in regard to the trunk, progression along the ground is to the animal a very difficult matter.

In the great imitative power of the Apes, the craftiness of the wily Fox, and the sagacity of the Elephant, we may see the modifications of instinct which are more or less observable in all, and in the exercise of which we may find much to admire and astonish us, whether we witness it amongst the unreclaimed in their native haunts, or in the domesticated about the abodes of men: in the former it is especially interesting, though very much so also in the latter; and how many are the pleasing anecdotes recorded of the instinct of animals as exhibited in such as have become familiarized. To that power man is greatly indebted as exercised by those animals which have been tamed and rendered subservient to his purposes. What he owes to the labour of the Horse, to the prosperity of his flocks and herds, or to the faithful companionship of the Dog, need scarcely be mentioned, being all self-evident.

In the vast diversity of form, and wide differences of size, how much there is to attract and engage us; whether we gaze on the massive structure of the Elephant, or the light and graceful outline of the Antelope; the huge, unwieldy Whale, or the tiny creeping Mouse. How much, in the fleet and bounding step of the Gazelle, and the slow movements of the Ant-eater; in the gay and lively actions of the Squirrel, or the dulness of the Sloth. So likewise in the singular provision of the pouch amongst the Marsupials, whose young, brought forth at an early period, require some special protection in their then utterly defenceless state, and again in the extraordinary forms of the Echidna and the Duckbill.

The covering of the members of this class too, is a subject deeply interesting, regarded either in connection with their own economy, or in relation to man. The spiny covering of the Porcupine contrasts strongly with the woolly coat of the Sheep; the thick, almost naked skin of most of the Pachyderms, with the long, silky hair of the Llama. The smooth and closely adpressed hair of the Seal, points to its fitness as a clothing for an animal whose life is chiefly spent in the water; while the smooth and naked skin of the more aquatic Whale, is evidently best suited to the almost fish-like habits of the Cetaceans.

These are a few of the subjects of interest, rapidly sketched, which are to be met with in studying the forms and habits of the members of this class, and viewed in connection with the circumstances under which they severally live, attest "the wisdom of God in Creation."

I.—Class MAMMALS *(Mammalia).*

Faculties in most advanced state of perfection; powers of motion varied; sensations delicate; intelligence superiorly developed; young suckled; mostly fitted for walking; a few are enabled to fly, and some are destined to live in the water.

1. Sub-Class.—PLACENTAL MAMMALS *(Placentalia).*

I. ORDER.—Man (Primates).

Position of body vertical; senses delicate, and nicely balanced; organs of voice pre-eminent; intelligence in a high degree; capable of progressive development.

1. **Family.**—*Men* (Hominidæ). Characters as in Order.

II. ORDER.—Four-handed Mammals (Quadrumana).

Limbs more or less lengthened; possess four organs of prehension similar to hands, generally with an opposable thumb on each.

1. **Family.**—*Apes* (Simiidæ). Nostrils divided by a narrow septum; opposable thumbs on fore and hind feet; generally naked callosities on rump; sometimes cheek pouches; usually furnished with a tail. Dentition incis: $\frac{4}{4}$— can. $\frac{1-1}{1-1}$—pre mol: $\frac{2-2}{2-2}$ —mol: $\frac{3-3}{3-3}=32$.
2. **Family.**—*American Monkeys* (Cebidæ). Nostrils separated by a broad septum; thumbs sometimes absent on fore feet; no callosities

or cheek pouches; tail often prehensile. Dentition incis: $\frac{4}{4}$—can: $\frac{1-1}{1-1}$—mol: $\frac{6-6}{6-6}=36$.

The *Iacchi* have only five grinders on either side of each jaw.

3. Family.—*Lemurs* (Lemuridæ). Muzzle pointed; fur woolly; grinders tubercular; tail sometimes long, sometimes absent; first, or second and third toes of hind foot furnished with claws. Some have large nocturnal eyes. Incisors varying in number in upper and lower jaws.

4. Family. — *Flying-Lemurs* (Galeopithecidæ). Hairy skin, expanded from sides of body, extending between fore and hind legs, and including the tail; toes furnished with sharp compressed claws; cutting teeth pectinated. Habits nocturnal.

III. ORDER.—Bats (Cheiroptera).

Fingers of fore limbs very long, connected by a membrane, which is continued to unite the anterior and posterior extremities, forming wings, by which the animals are enabled to fly.

1. Family.—*Insectiverous Bats* (Vespertilionidæ). Grinders acutely tubercular; index, or first finger, with one or two phalanges, without a nail; many have a nasal disk expanded in the form of a leaf. Those which are peculiar to the new world have three phalanges to middle finger; the others have but two.

2. Family.—*Frugiverous-Bats* (Harpyidæ). Grind-

ers bluntly-tubercular; index with three phalanges, usually furnished with a nail; without nasal disk. Generally of larger size than the *Vespertilionidæ*

IV. ORDER.—Insect-feeders (Insectivora).

Teeth beset with conical points; limbs short; feet mostly plantigrade; mammæ ventral. Nature timid; habits mostly nocturnal, subterraneous, frequently aquatic.

1. Family.—*Moles* (Talpidæ). Head long, narrow, somewhat depressed; nose much prolonged, pointed, flexible; eyes very minute; ears hidden; feet plantigrade. The more typical forms have anterior limbs largely developed and furnished with strong nails adapted for digging; tail of various lengths.
2. Family.—*Elephant Mice* (Macroscelididæ). Head conical; nose lengthened into a trunk; eyes large; hind legs and feet long; fur long and soft; habits of the Jerboas.
3. Family.—*Banxrings* (Tupaiidæ). Head broad, somewhat depressed, tapering to a pointed muzzle, which is divided in the centre by a furrow; eyes large; ears naked; feet plantigrade; toes long, five in number; tail often broad and hairy like the squirrels, sometimes hairy only at the tip; habits arboreal.
4. Family.—*Hedgehogs* (Erinaceidæ). Muzzle pointed; eyes small and prominent; body covered above with sharp spines; feet with five toes,

nails strong. Some have the power of rolling themselves up.

V. ORDER.—Rapacious Mammals (Carnivora).

Teeth more or less trenchant, canines large and pointed, six incisors in each jaw; muscular energy great. By a comparison of the tubercular portions of the teeth with the cutting parts, the degree of sanguinary appetite, in these animals, can be determined.

1. Family.—*Dogs* (Canidæ). Muzzle lengthened; jaws with three false molars above, five below; two true molars, behind each carnivorous tooth; tongue smooth; limbs lengthened; tail generally more or less bushy; feet digitigrade. The diurnal Canidæ have the pupils round; the nocturnal have them elliptical; and many have the feet furred beneath.
2. Family.—*Civet Cats* (Viverridæ). Muzzle long; form lengthened, comparatively low; body somewhat compressed; one true molar in lower jaw, two in upper jaw, two tubercles on inner side of lower carnivorous tooth; tongue covered with sharp papillæ; claws semi-retractile; anal pouch with glands which secrete an odorous matter; fur generally spotted, that of tail annulated.
3. Family.—*Cats* (Felidæ). Muzzle short and rounded; jaws short; number of teeth small, no true molar in lower jaw, one very small in

upper; upper carnivorous tooth three lobed, with a broad heel inside, lower two lobed, no heel; tongue roughened by horny, recurved papillæ; body compressed; anterior limbs massive; digitigrade. Habits chiefly nocturnal.

4. **Family.**—*Weasels* (Mustelidæ). Muzzle short, obtuse; body long, slender, flexible; limbs short; tail lengthened; one true molar on either side of each jaw; digitigrade; stature small; disposition very sanguinary. They diffuse, when alarmed, a fetid stench. False molars in the typical forms $\frac{3-3}{4-4}$.

5. **Family.**—*Skunks* (Mephitidæ). Muzzle slightly elongate, obtuse; body heavy; limbs stout; tail short and bushy, usually erect; claws strong; lower carnivorous tooth with two tubercles on inner side; feet plantigrade; hair of body generally longitudinally striped. Commonly mephitic.

6. **Family.**—*Bears* (Ursidæ). Body usually heavy, with or without a tail; limbs long and thick; plantigrade; claws strong; cartilage of nose elongated and moveable; lips generally mobile; tongue extensible; molars tubercular. Most have the power of climbing trees. Habits omnivorous.

7. **Family.**—*Seals* (Phocidæ). Body lengthened, tapering posteriorly; feet short, in the form of flippers; toes connected by a membrane; teeth variable; fur short and close. Able

swimmers, and spend the greater part of their time in the water.

VI. ORDER.—Cetaceans (Cetacea).

External appearance somewhat fishlike; body generally covered with a smooth skin; anterior limbs in the form of paddles; no posterior limbs; tail expanded horizontally into a fin of greater or less breadth.

I. *SUB-ORDER.*—Carnivorous Cetaceans (Carnivora).

Skin smooth, shining, generally destitute of hairs; nostrils in the form of spiracles and pierced on summit of head; mammæ placed near vent; teeth conical or wanting.

1. Family.—*Baleen-Whales* (Balænidæ). Head large; upper jaw much arched; no teeth, but from each side of the upper jaw is suspended a series of plates of baleen or whalebone, the edges of which are formed into a loose fringe of fibres which fill cavity of mouth; spiracles on upper part of head; with or without a dorsal fin.
2. Family.—*Sperm-Whales* (Physeteridæ). Head very large, with an extremely obtuse snout; lower jaw narrow, corresponding to a groove in upper, and furnished with a row of conical teeth which fit into cavities on edge of palate when the mouth is shut, there being no teeth in upper jaw; blow-hole situated on anterior part of head.

3. Family.—*Dolphins* (Delphinidæ). Head small, short, and rounded, or lengthened into a beak; jaws generally furnished with a number of conical teeth; with or without a dorsal fin. For the most part of comparatively small size, and in form taper towards each extremity.

II. *SUB-ORDER.*.—Herbivorous-Cetaceans (Herbivora).

Grinders with flat crowns; two mammæ on breast; hairy whiskers; orifices of nostrils pierced at end of muzzle.

4. Family.—*Manatees* (Manatidæ). Skin thick, and coarse-grained, with a few scattered hairs; head conical; muzzle large and fleshy, two tufts of stiff bristles at its sides; upper lip cleft; mouth moderate; nails on edges of swimming paws; tail terminated by a lengthened oval fin; grinders $\frac{8-8}{8-8}$; no cutting or canine teeth in adult.
5. Family.—*Dugongs* (Halicoridæ). Skin smooth, with a few scattered hairs; head small in proportion, and of a peculiar form, owing, in great measure, to the large, thick, and truncate upper lip, forming a blunt thick snout, truncated portion furnished with bristles; nostrils on summit of upper jaw at the point where it is bent down; two cutting teeth in upper jaw in form of tusks, grinders $\frac{5-5}{5-5}$; caudal fin bilobed.

5. Family.—*Stellerines* (Rytinidæ). Skin thick, hard, rugged, forming a kind of cuirass of agglutinated hairs; head small, obtuse; nostrils at end of snout; lips double, space between lips filled with strong bristles; no external ears; teeth horny $\frac{1-1}{1-1}$ attached to the gums, having no insertion in the bones; tail ending in a stiff crescent-shaped fin.

VII. ORDER.—Pachyderms (Pachydermata).

Form heavy, unsymmetrical; skin thick, hard, deeply furrowed, generally but scantily clothed with hair; toes included in a skin and tipped with broad nails, or enclosed in hoofs; teeth often very large; some have the nose lengthened into a proboscis.

1. Family.—*Hippopotami* (Hippopotamidæ). Form unwieldy; skin smooth; head large, terminated by a broad swollen muzzle; mouth very large; four incisors and two canines in each jaw, lower canines long, thick and bent, forming large tusks; legs very short; four toes on each foot, terminated by small hoofs. Habits aquatic.
2. Family.—*Elephants* (Elephantidæ). No front teeth in lower jaw, two large projecting tusks in upper jaw, which grow from a persistent pulp; nose greatly prolonged, forming a proboscis of extraordinary flexibility and prehensive power, and furnished at tip with a small finger-like appendage; limbs very mas-

sive; toes five on each foot, included in hard skin.

3. **Family.**—*Tapirs* (Tapiridæ). Nose lengthened into a short proboscis of considerable flexibility and prehension; six incisors and two canines in each jaw; fore feet have each four toes, hind three, cased in small hoofs at tip.

4. **Family.**—*Hogs* (Suidæ). Muzzle long, narrow, and truncate; nose mobile; incisors variable; canines large and projecting, those of upper jaw turned up, lower longer, often very angular, recurved; skin covered with strong, stiff hair; tail rather short, or none; legs rather short; feet with four toes furnished with hoofs, the two middle toes being considerably the largest, postero-lateral pair small and scarcely reaching the ground.

5. **Family.**—*Rhinoceri* (Rhinocerotidæ). Skin of extraordinary strength and thickness, often arranged in folds; nose furnished with one or more formidable recurved horns; upper lip long and flexible; toes three in number on each foot, shod with blunt hoofs.

6. **Family.**—*Damans.* (Hyracidæ). Form somewhat like the Rodents; size not exceeding that of a Hare; muzzle and ears short; tail a mere tubercle; body clothed with fur; two incisors in upper jaw, four in lower; three or four toes to each of fore feet, three to hind, united by the skin to the nails, which

are short, broad, and flat, except the inner posterior toes which are armed with a crooked nail.

VIII. ORDER.—Single-hoofed Mammals (Solipedes).

Hoofs undivided; six cutting teeth in each jaw; upper lip whole and mobile. Use their hind legs in defence.

1. Family.—*Horses* (Equidæ). Characters as given in order. Some have tail covered with long hair throughout its length, others have long hair only at tip. The *Equine* group have a wart on inside of each leg; the *Asinine* have a wart on inside of fore legs only.

IX. ORDER.—Ruminants (Ruminantia).

No incisors in upper jaw, a considerable space between incisors of lower jaw and molars, crowns of molars marked with a double row of crescents; feet with two toes in front, furnished with hoofs, which appear like a single hoof cleft, behind and rather elevated are two small, and more or less rudimentary toes provided with hoofs; generally furnished with horns.

1. Family.—*Camels* (Camelidæ). Without horns; upper lip cleft; canine teeth in both jaws; feet broad, expanded, elastic, terminated by two small hoofs; generally one or more protuberances on back.
2. Family.—*Deer* (Cervidæ). Horns solid, deci-

duous, covered with a hairy skin when growing, generally more or less branched or palmated; usually provided with lachrymal sinuses.

3. FAMILY.—*Musks* (Moschidæ). Without horns; long projecting canine teeth in upper jaw of males; size small; of slender and very elegant proportions; no lachrymal sinus.

4. FAMILY.—*Giraffs* (Cameleopardalidæ). Permanent, solid, simple horns in both sexes, always covered with a hairy skin, crowned with a tuft of stiff, upright hairs; neck very long; fore legs disproportionate in length; tail rather long, and tufted; tongue long, prehensile; whole appearance graceful.

5. FAMILY.—*Hollow-horned Ruminants* (Bovidæ). Horns persistent, sheathing a bony core, round, or compressed and angular, often annulated, bent or curled in various ways; with or without lachrymal sinus; tail short, or elongated and tufted.

The *Antelopes* (Antilopinæ). Have the limbs long and slender in the typical species, general contour light and graceful; no dewlap; tail short and hairy. The more aberrant species assume a more or less bovine or caprine form; the former are of large size with heavy bodies, tail lengthened and tufted; the latter have rather heavy bodies, and stout limbs, legs short, hoofs large; tail short and flat. Muzzle narrow or broad. Horns conical, or angular; straight, recurved, lyrate, or spirally twisted, frequently annulated; sometimes large and approximated at base, descend, and turn up at point.

The *Goats* (Caprinæ). Have a narrow clothed muzzle; chin generally well bearded; hair sometimes long and shaggy; limbs short and stout; hoofs large; tail depressed and hairy; horns generally large, directed upwards, backwards, and outwards.

The *Sheep* (Ovinæ). Have the muzzle narrow and clothed; limbs strong; horns angulated, rugose, massive, directed backwards, then drooping assume a more or less spiral form.

The *Oxen* (Bovinæ). May be known by their large and powerful form, short neck, dewlap, comparative shortness of legs in proportion to length and bulk of bodies, and their broad naked muzzle; tail generally long and tufted; horns usually round and tapering, sometimes flattened, occasionally very massive at base.

X. ORDER.—EDENTATES (Edentata).

No front teeth, or toothless; molars, when present, of simple structure, being destitute of enamel and of distinct roots; large claws embracing extremities of toes; the whole group marked by a want of agility.

1. FAMILY.—*Sloths* (Bradypodidæ). Head short and rounded; no cutting teeth, canines rather pointed, molars cylindrical; two pectoral mammæ; anterior limbs long and weak,

adapted for suspension; toes completely joined by skin, and armed with very long, strong, compressed, and curved claws; tail none.

2. **Family.**—*Armadillos* (Dasypodidæ). Head long and pointed, mouth small, tongue somewhat extensible; no cutting or canine teeth; grinders cylindrical; body covered by a hard, scaly armour; fore feet with four or five toes, hind feet five. They have the power of rolling themselves up.
3. **Family.**—*Earth-Hogs* (Orycteropodidæ). Head lengthened and pointed, tongue extensible; form bulky, long, and low; skin thick, covered with bristles; nails thick and fitted for digging; grinders $\frac{6-6}{6-6}$, cylindrical, and traversed in a longitudinal direction by a number of little canals.
4. **Family.**—*Anteaters* (Myrmecophagidæ). Head generally very long, tapering to a point; mouth small, toothless, tongue long, exsertile; body long, thickly clothed with long hair; tail long and bushy, or naked at tip and prehensile; or body and tail covered with dense horny imbricated scales; claws long, cutting, incurved. Walk on sides of feet.

XI. ORDER.—Rodents (Rodentia).

Two long curved incisors in each jaw, which are bevelled off on inner surface, and always present a sharp cutting edge, a wide space between these and molars, which have flat or blunt tuberculated crowns; eyes large and lateral.

1. FAMILY.—*Squirrels* (Sciuridæ). Head rather broad; eyes large and prominent; fore feet with four toes, hind five; tail more or less lengthened, generally very hairy and expanded in the arboreal species, bushy in the terrestrial; some have skin of body extended between limbs; fur usually soft. For the most part lively and agile.
2. FAMILY.—*Jerboas* (Jerboidæ). Head large; eyes very prominent; fore feet short, with five toes; hind legs and feet very long, with three, four, or five toes; tail very long and tufted; fur soft. Progress by leaps.
3. FAMILY.—*Rats* (Muridæ). Teeth with tubercular crowns; muzzle conical; nose somewhat prolonged; facial line nearly straight, or slightly curved; or with nose short and blunt, and facial line more curved; ears rounded; tail long, tapering, and scaly, scantily clothed with hair; toes usually long.
4. FAMILY.—*Voles* (Arvicolidæ). Molars with flat crown; head blunt; facial lines much arched body usually stout; tail scaly, sometimes clothed, and rather tufted at apical portion, generally about half the length of body, sometimes longer.
5. FAMILY.—*Mole-Rats* (Spalacidæ). Head large and blunt; eyes very small; sometimes furnished with cheek pouches; body thick, cy-

lindrical; tail absent or very short; limbs short; cutting teeth often very large.

6. **Family.**—*Spiny-Rats* (Echimyidæ). Facial line slightly curved; nose generally blunt, sometimes rather produced, giving a more murine aspect; tail usually very long, scaly, but more or less clothed with hair, occasionally forming a brush at end; body clothed with fur, more or less intermixed with strong, grooved, lance-like spines, or with longer and larger hairs, which are flattened and grooved like the spines; molars with flat crowns.

7. **Family.**—*Porcupines* (Hystricidæ). Body more or less armed with spines; muzzle broad, thick, clothed with soft hairs; facial line rather hollow between eyes and nose; upper lip slightly notched or divided by a vertical groove; tail short, and furnished with spines, or long, more or less destitute of hair at apical portion and prehensile; soles of feet naked and smooth, and having five toes, or with expanded and rough soles, and toes 4–5 or 4–4.

8. **Family.** — *Chinchillas* (Chinchillidæ). Head broad; eyes placed far back; whiskers long; ears large, rounded or elongated; tail long or moderate, recurved and bushy; toes 4–3, 4–4, or 5–4; fur soft.

9. **Family.** — *Cavies* (Caviidæ). Head generally large and thick; facial line nearly straight or slightly curved; eyes large; upper lip

entire; body generally clothed with coarse hair, which is sometimes very long on hinder parts of back; tail wanting, or rudimentary; limbs short, or long and fitted for running; feet naked beneath; toes 4–3, 5–3, or 5–5, nails strong, sometimes almost hoof-like.

10. **Family.**—*Hares* (Leporidæ). Upper lip cleft; tip of muzzle clothed; four incisors in upper jaw, two small ones being hidden behind the front pair, which are grooved, lower incisors smooth, always white and shorter than in most other rodents; tail short and turned up or not visible; fur soft; soles of feet hairy. Dentition in. $\frac{4}{2}$, molars $\frac{6-6}{5-5}$ or $\frac{5-5}{5-5}$.

II. Sub-Class.—APLACENTAL MAMMALS (*Aplacentalia*).

I. ORDER.—Marsupials (Marsupialia).

Females of most of these animals provided with a peculiar pouch on lower part of abdomen for the reception of their young, which are brought forth prematurely; scrotum of male hangs before penis both sexes have two bones *(marsupial bones)* attached to pelvis anteriorly. With the exception of the Wombat *(Phascolomys)* none have the same number of incisors in both jaws.

1. **Family.** — *Opossums* (Didelphidæ). General contour rat-like, with muzzle longer and naked at tip; tail long, very scantily clothed, covered by a scaly skin, prehensile; feet with

five toes, furnished with claws, except inner toes of hind feet; plantigrade; pouch sometimes rudimentary. Dentition in. $\frac{10}{8}$, can. $\frac{1-1}{1-1}$ pre-molars $\frac{3-3}{3-3}$, molars $\frac{4-4}{4-4}$, molars tuberculous.

2. FAMILY.—*Dasyures* (Dasyuridæ). Head rather depressed, tip of muzzle naked; five well developed toes on fore feet, nails crooked; hind feet with the thumb small resembling a tubercle, or absent, and four disunited toes; tail long, well clothed, non-prehensile; pouch sometimes absent. Dentition in. $\frac{8}{6}$, canines large, molars trenchant.

3. FAMILY.—*Bandicoots* (Peramelidæ). Head long, very pointed, tip of muzzle naked; ears sometimes very large; outer toes of fore feet resembling tubercles, the others fully developed; hind feet considerably longer than fore, inner toes sometimes present, but rudimentary, the two next united as far as the nails, the fourth large and furnished with a strong nail; pouch opening backwards. Dentition in. $\frac{10}{6}$, in. $\frac{1-1}{1-1}$, pre-mo. $\frac{3-3}{3-3}$, molars $\frac{4-4}{4-4}$.

4. FAMILY.—*Phalangers* (Phalangistidæ). Head broad, short, tip of muzzle naked, upper lip cleft; fore feet with five toes, armed with compressed curved claws; hind feet with a nail-less opposable thumb, remainder furnished with curved claws, second and third toes united; skin sometimes expanded from sides of body and extended between fore and hind

legs; tail generally long, frequently prehensile; pouch well developed. Dentition in. $\frac{6}{2}$, can. $\frac{1-1}{1-1}$ or $\frac{1-1}{0-0}$, pre-mo. $\frac{1-1}{1-1}$, mo. $\frac{4-4}{4-4}$ or $\frac{3-3}{3-3}$.

5. Family. — *Wombats* (Phascolomyidæ). Head large, flat, eyes small; upper lip cleft; muzzle obtuse, tip naked, nostrils widely separated; body stout; limbs short; feet broad; tail only a tubercle; fur long and coarse; nails on toes of fore feet broad and solid, on hind toes curved; teeth bearing a general resemblance to the *Rodents.* Dentition in. $\frac{2}{2}$, grinders $\frac{5-5}{5-5}$.

6. Family.—*Kangaroos* (Macropodidæ). Muzzle elongated, contracted; upper lip cleft; fore legs small, with five toes; hind legs very long and powerful, two inner toes small and united, the next large, long, and armed with a very strong claw; tail long and strong; pouch well developed; fur soft. Dentition, in. $\frac{6}{2}$, can. $\frac{0}{0}$, or $\frac{1-1}{0-0}$, pre-mo. $\frac{1-1}{1-1}$, molars $\frac{4-4}{4-4}$.

II. ORDER.—Monotremes (Monotremata).

Animals so called on account of their possessing but one opening *(cloaca)* for all their excretions. Have no pouch, but have marsupial bones; toothless, or provided with horny teeth.

1. Family.—*Porcupine Ant-Eaters* (Echidnidæ). Snout long and narrow; mouth very small; tongue protractile; body covered above with strong sharp spines; legs short, thick, and strong, a spur on hind foot of males; toothless.

2. **Family.**—*Duck-Bills* (Ornithorhynchidæ). Body depressed, tapering at each extremity, clothed with a mixture of crisp and soft fur; muzzle elongated, flattened, somewhat like a duck's-bill, and covered with a thick skin; tail short and flat; feet webbed, the membrane continued beyond the toes; a spur on hind foot of the males; teeth horny.

BIRDS.

The arrangement chosen for this class, is that employed by Mr. G. R. Gray in his "Genera of Birds," with such slight alterations as were thought to be necessary. That arrangement appears to be the best which has hitherto been brought forward, yet much remains to be done by travellers and others, having opportunity for making original observations, towards determining the natural affinities of species and groups, which object can be greatly aided by carefully recording, in detail, the habits of such species as may come under their observation.

Much has been written upon birds, by many authors, both of ancient and modern date, though the wonder is that more has not been written, for a general interest seems to have been always felt in them, which is not at all surprising, when we consider the charm they lend to nature, and the surprising manifestation of a beautiful adaptation of means to ends exhibited in their conformation.

No place appears cheerful without them; the landscape seems imperfect in their absence. The Swallow must flit around the old church spire, the Rook strut upon the glade, the Daw must harbour in the ruined castle, the Wagtail follow the plough. The comfort too which man derives from the domesticated sorts is sufficient to interest him largely in these, whether they are kept as articles of food, or as objects of ornamental attraction. Nor is superstition a small source from which attraction has sprung; numerous spots in Old England may even now be found where the Raven's croak is still regarded as an omen of ill; and many a ghost story is still rehearsed around the winter fire, originating in some benighted swain's having been startled in the woods by the hobgoblin hootings of an Owl. But it is in their native haunts where birds are best seen to perfection, and where they interest us the most, some being confined to comparatively limited spots, — others having a world-wide range. The Swallow tribes, impelled by the nature of their food to lead a migratory life, may be said to live in a perpetual summer, and to spend the greater part of their existence on the wing; the fine plumaged Trogons, the Puff-birds, and the Jacamars, dwell in the woods of tropical America; in the deep recesses of the forest, the Todies, the Boatbills, and the Motmots take up their abode, and there, in keeping with the gloom which pervades such spots, utter their melancholy croak. In the soft twilight the Goatsuckers course the pasture land, the river margin, and the swamp, and hunt around the woods for those insects of crepuscular habits, on which they subsist; while the beautiful Sun-birds of the Old World, amidst the glare of day, seek the flowers from which to sip the nectar; and the Humming-birds of the New World, glittering with dazzling brilliancy, poise themselves around the blossoms, to pluck from them the insects which there lie hid. In Australia, the Honey-eaters, more retired, creep among the foliage, and find their food in the flowers of the *Eucalypti* and other plants. In all parts of the world the Creepers are seen climbing the trunks and branches of trees, in search of the minute creatures which conceal themselves in the fissures of the bark; while the Fly-catchers enjoy a like extended range, charming the woods with their song, or enlivening them by their activity; and among the trees which border streams their short and fitful flight may often be seen, as they dart forth to seize some passing insect. Pasture lands are the resort of the Starlings and the noisy Crows; the sterile expanse and sandy deserts of Africa and Asia furnish subsistence and a home for the Sand-grouse; the Plovers frequent the moorland and the plain; the sly and timid Rails seek their food and screen themselves from observation amidst the long rank grass and sedge which grow in the marsh; along the swamps, the sandy margin of the stream, or the sea-shore, in all parts of the world, may be heard the whistle of the Curlew, the Sandpiper, and the Snipe, some representative being every where found; while the little Phalarope may be seen swimming buoyantly on the sea, the lake, or the fresh-water pond. In the quiet, lonely pool, or sequestered swamp, the Heron may be detected standing, silently watching for its prey; the migratory Spoonbill has a similar resort; and the Crane, and the Stork seek their food alike in the morass or the open plain. The Geese and the Ducks are universally observed, some frequenting the rivers, others resorting to the sea, while some find sustenance on the shores and flats left exposed by the retiring tide. The Gulls seek for food near the sea-coast, or resort to cultivated lands in search of worms; a few lead a piratical life, and subsist by plundering other species. The Albatros and the Petrels roam at large over the waste of waters; the Divers, the Grebes, and the Auks, are found in bays, creeks, rivers, or near cliff-bound coasts, in all parts of the world; while the singularly formed Penguins select their habitations around the rocky islands of the Southern Ocean.

The architecture of birds is also a subject for our admiration. The curiously constructed nests of the Weavers of Africa, and the beautifully woven cradles of the Hangnests, suspended in numbers together from the slender branches of trees in the forests of tropical America, are among the most remarkable; though not less interesting are those of others, particularly when taken in connection with the conditions under which they live. The heaps of vegetable matter brought together by the Mound-bird of Australia, wherein several females deposit their eggs to be hatched by the heat developed during fermentation, astonish us by their novelty; and amongst other extraordinary habits may rank that of the Bower-birds of the same country, for whose singular bower-like erections it is difficult to determine a use. These, with numberless others, form subjects for pleasing investigation; and the more such enquiries are pursued, the keener will be the interest taken in them, for truly in nature every charm is really supreme.

II. CLASS.—BIRDS (Aves).

Body clothed with feathers; anterior limbs constructed for flight (with few exceptions); bills horny; feet covered with a scaly skin.

I. ORDER.—Rapacious Birds (Accipitres).

Bill strong, upper mandible sharp, pointed, and curving downwards; cutting margins toothed or festooned; nostrils pierced in a membrane *(cere)* investing the base of the bill; talons sharp, strong, much hooked; muscular power great.

I. *SUB-ORDER.*—Diurnal Rapacious Birds (Diurni).

Eyes placed laterally.

1. Family.—*Vultures* (Vulturidæ). Head more or less denuded; eyes level with surface of cheeks; bill not toothed, lateral margins of upper mandible rather sinuous, extensively covered with the cere; tarsi short and covered

with reticulated scales; claws but slightly curved, blunt; crop prominent.

2. Family.—*Falcons* (Falconidæ). Head clothed; eyes sunk; bill more or less curved from base; cutting margins toothed, festooned, or sinuated; tarsi variable in length, usually covered in front with large scales, seldom reticulated; claws much curved, very acute.

II. *SUB-ORDER.*—Nocturnal Rapacious Birds (Nocturni).

Eyes large, placed in front, surrounded by a circle of radiating feathers.

3. Family.—*Owls* (Strigidæ). Head large; bill short, much hooked, upper mandible entire, lower notched; tarsi and toes more or less feathered.

II. ORDER.—Perching Birds (Passeres).

Feet more or less formed for clasping the branches of trees; toes generally three before and one behind, sometimes two and two. Very numerous; divided into the *Fissirostral*, *Tenuirostral*, *Dentirostral*, and *Conirostral* tribes.

I. *SUB-ORDER.*—Fissirostral Birds (Fissirostres).

Gape wide, extending beneath eyes; feet variously formed; tarsi nearly always short.

1. TRIBE—Nocturnal Fissirostral Birds (Nocturni),

Eyes very large; plumage dingy, soft, downy.

1. **Family.** — *Goatsuckers* (Caprimulgidæ). Bill very wide at base; margins of upper mandible sometimes folding over lower, occasionally provided with a tooth, short and compressed at tip; gape furnished with long stiff bristles. Many have inner side of claw of middle toes serrated.

2. TRIBE. Diurnal Fissirostral Birds (Diurni).

Eyes smaller; plumage compact.

2. **Family.**—*Swallows* (Hirundinidæ). Bill small, weak, very broad at base; tarsi very short, occasionally feathered; sometimes all the toes turned in front; claws curved; wings very long and pointed; plumage more or less glossy.
3. **Family.** — *Wood-Swallows* (Artamidæ). Bill stout, broad at base, more or less compressed; culmen rounded, curved from base to the tip; nostrils round, pierced in substance of bill; upper mandible distinctly notched near tip; tarsi short, strong, covered with broad scales; toes rather long; claws strong and compressed; wings long and pointed.
4. **Family.**—*Trogons* (Trogonidæ). Bill short, broad at base, narrowed and curved to tip, margins serrated or notched near tip, base furnished with bristles; tarsi short, small, more or less feathered; toes two before, two behind; plumage very rich.
5. **Family.**—*Rollers* (Coraciadidæ). Bill broad at

base, varying in length, curved to the tip, where the upper mandible is more or less bent over the lower, margins sometimes serrated, sometimes notched near tip; tarsi usually short; toes three before, one behind; wings generally lengthened and pointed.

6. Family.—*Kingfishers* (Alcedinidæ). Bill broad at base, lengthened, generally straight, tip acute where upper mandible is sometimes bent over, culmen often keeled; tarsi short, robust, occasionally partly clothed with feathers; toes 3—1, 2—2, or 2—1.

7. Family.—*Bee-Eaters* (Meropidæ). Bill assuming the tenuirostral character, long, curved, acute, compressed, culmen carinated; wings sometimes long and pointed; tarsi short; toes rather long, lateral ones more or less united to middle toes; claws curved; tail long, with sometimes the two middle feathers prolonged.

II. *SUB-ORDER.*—Tenuirostral Birds (Tenuirostres).

Bill varied in form and length, often arched and compressed, always slender and acute; tongue often extensible and ending in a brush of filaments; tarsi usually short; hind toe strong, and armed with a strong claw.

8.—Family.—*Hoopoes* (Upupidæ). Bill long, slender, more or less arched, much compressed; tarsi strong; claws strong and curved; outer toe partly united to the middle one; wings somewhat rounded.

9. **Family.**—*Sun-Birds* (Promeropidæ). Bill generally lengthened, slender, curved or straight, gradually compressed from base to tip, cutting margins sometimes finely toothed ; nostrils covered by a long membranous or hard scale ; claws curved and acute. Males generally remarkable for brilliancy of plumage.

10. **Family.**—*Humming-Birds* (Trochilidæ). Bill more or less long, slender, straight or curved, generally acute; tongue long, capable of being darted forward at the will of the bird ; tarsi very short, more or less clothed with feathers; toes more or less united at base; claws curved; wings very long.

11. **Family.**—*Honey-Eaters* (Meliphagidæ). Bill variable in length, of moderate strength, curved, often rather broad at base and gradually compressed to tip, which is acute and notched, sometimes subconic; nostrils in a large groove, covered by a scale ; tongue extensile, with a pencil of fibres at tip ; outer toe united at the base.

12. **Family.**—*Creepers* (Certhiidæ). Bill more or less lengthened, often slender, compressed, arched, or with culmen curved or straight ; nostrils covered by a scale, or with bill broader and nostrils placed in a long groove; tarsi and toes very strong, the latter furnished with curved claws, hind toe long, and armed with a strong claw; tail feathers often rigid, with shaft projecting and pointed.

Many have the central portion of the feathers light with a dark margin, or dark with a light margin, giving them a mottled appearance.

III. *SUB-ORDER.*—DENTIROSTRAL BIRDS (Dentirostres).

Upper mandible more or less notched near tip, and bent over lower; gape often furnished with bristles; tarsi comparatively slender; toes formed for perching.

13. FAMILY. — *Warblers* (Lusciniidæ). Bill generally slender, straight, more or less depressed at base, which is sometimes furnished with bristles; nostrils placed in a groove; tarsi generally elevated, slender; claws curved, acute; eyes, in most, bold and prominent; plumage soft and loose. Mostly of solitary habits.

The Tit-mice *(Parinæ)* have the bill stronger and more conical; and the tarsi, toes, and claws stouter than most others.

14. FAMILY. — *Thrushes* (Turdidæ). Bill strong, sides compressed more or less, culmen carinated, straight or curved to tip, which in some cases is considerably bent over, dentition variable; gape sometimes bristled; tarsi and toes strong; hind claw rather long; wings moderate, generally rounded.

15. FAMILY.—*Flycatchers* (Muscicapidæ). Bill depressed, broad at base, narrowed to tip, where upper mandible is suddenly bent over and notched; gape furnished with bristles; nos-

trils round, frequently exposed; feet short and weak; claws moderate; tail often lengthened.

16. **Family.**—*Chatterers* (Ampelidæ). Bill short, strong, broad and more or less depressed at base, culmen more or less curved to tip where upper mandible is bent down and notched; gape wide, generally without bristles; tarsi short and strong; claws very strong; tail often very short.

17. **Family.**—*Butcher-Birds* (Laniidæ). Bill strong, culmen curved more or less, a deep notch near tip of upper mandible, which is hooked, generally a few bristles at base; nostrils round; tarsi of moderate length and strong; claws acute.

IV. *SUB-ORDER.*—CONIROSTRAL-BIRDS (Conirostres).

Bill of various lengths, strong, conical, seldom notched; feet well developed, fitted for walking or perching, tarsi boldly scutellate; wings generally pointed.

18. **Family.**—*Crows* (Corvidæ). Bill strong, somewhat compressed, generally straight, sometimes arcuated, or upper mandible gently curved to tip, which is sometimes slightly inflexed; nostrils frequently covered with stiff feathers, directed forwards; tarsi strong, covered with thick scales; wings generally long and pointed.

19. **Family.**— *Corvine-Starlings* (Chlamyderidæ). Bill strong, not very lengthened, more or less

compressed, culmen curved to tip, commissure curved, upper mandible inflexed and emarginated at tip; nostrils generally round, exposed, or partly covered by frontal plumes; wings moderate and pointed; tail often lengthened; tarsi rather long, strong; toes and claws strong, especially the hind claw.

20. Family.—*Starlings* (Sturnidæ). Bill in form of a compressed cone, culmen more or less advancing on forehead, straight or very slightly inflexed near tip, commissure greatly angulated at base, upper mandible rarely emarginate; frontal feathers advancing to posterior part of nostril-openings; wings moderate and pointed; tail often short.

21. Family.—*Finches* (Fringillidæ). Bill short, thick, conical, broad, and often angular at base, more or less pointed at tip, where upper mandible is sometimes slightly inflexed, commissure angulated at base, or sinuated; tarsi of about equal length to middle toe, hind claw more or less lengthened.

22. Family.—*Colies* (Coliidæ). Bill short, broad at base, culmen elevated and arched; nostrils naked, placed in a large membranous groove; wings short, pointed; tail long, cuneated. Possess the power of turning all the toes forwards.

23. Family.—*Plantain-Eaters* (Musophagidæ). Bill rather large, broad at base, compressed, culmen high, curved to tip, sometimes advancing

on forehead, lateral margins generally serrated; nostrils placed near middle and exposed; tarsi short, strong; outer toe frequently capable of being turned backwards; wings rounded.

24. Family.—*Hornbills* (Bucerontidæ). Bill very large, long, broad at base, curved and compressed to tip, upper mandible generally surmounted with protuberances of various shapes at base, which advance more or less on forehead; lateral margins serrated; tarsi short, strong.

III. ORDER.—Scansorial-Birds (Scansores).

Feet particularly formed for climbing, having two toes before and two behind; tarsi usually very short.

1. Family.—*Toucans* (Rhamphastididæ). Bill very large, light, cellular, long and compressed, curved to tip, margin serrated; tarsi short; toes long; wings rounded.

2. Family.—*Parrots* (Psittacidæ). Bill very strong, short, compressed, deep, upper mandible forming a short curve from base to tip, which bends considerably over and is much longer than lower, lateral margins of upper mandible sometimes toothed; nostrils placed in a cere; tarsi short, strong, and rounded.

3. Family.—*Barbets* (Capitonidæ). Bill thick, dilated at base, which is generally furnished with stiff bristles, compressed towards tip, culmen gently curved to the tip which is

slightly prolonged, sometimes inflexed, margins of upper mandible at dilated part falling deeply over lower; tarsi short; toes rather long; tail feathers soft; plumage brightly coloured.

4. FAMILY.—*Woodpeckers* (Picidæ). Bill lengthened, straight, angular, wedge-shaped, compressed, and more or less truncate at tip; tarsi short; toes long, particularly outer hind toe; tail feathers stiff and pointed.

The Wrynecks (*Yuncinæ*) have tip of bill acute, and tail broad and soft.

5. FAMILY.—*Cuckoos* (Cuculidæ). Bill very variable in size, generally more or less curved, culmen sometimes straight and inflexed at tip, generally curved, sometimes elevated and keeled, lateral margins of upper mandible arched or undulating, emarginated at tip; gape large; tarsi very variable in length, covered with large, broad scales; inner hind toe sometimes furnished with a long spur-like claw; wings rounded, or long and pointed; tail long and rounded.

IV. ORDER.—PIGEONS (Columbæ).

This embraces but one great group. The

1. FAMILY.—*Pigeons* (Columbidæ). Bill moderate, rather slender, soft at base, hard at tip, which is more or less elevated and arched; nostrils covered by a soft fleshy tumid membrane;

tarsi generally short, sometimes feathered, usually covered in front with broad scales, strong; toes moderate.

V. ORDER.—GALLINACEOUS, or GAME-BIRDS (Gallinæ).

Feet especially adapted to walking; legs long and strong; tarsi generally provided with one or more spurs; toes connected at their base by a membrane; claws blunt; wings short; bill arched.

1. FAMILY.—*Curassows* (Cracidæ). Bill varied in form, covered at base by a soft skin, more or less curved, sometimes much compressed, with culmen greatly elevated; nostrils generally exposed; cheeks more or less denuded; head sometimes crested or ornamented with curled feathers; tarsi without spurs; claws sometimes much curved; hind toe long and placed on a level with others, forming a good perching foot; tail lengthened and broad.

2. FAMILY.—*Mound-Birds* (Megapodiidæ). Bill not stout, rather weak, with culmen low at base, apical half slightly elevated and curved to tip; nostrils placed near middle of bill; tarsi very stout, without spurs; toes long; hind toes on same plane as the others; claws very long, slightly curved; wings rather large, rounded; tail sometimes very short.

3. FAMILY.—*Brush-Turkeys* (Talegallidæ). Bill strong, thick, somewhat compressed, culmen curved to tip; head and neck very scantily clothed, with skin brightly coloured and more

or less wattled; tarsi strong, without spurs; toes and claws long; tail long, and more or less broad.

4. FAMILY.—*Turkeys* (Meleagridæ). Bill broad at base, and invested by a soft membrane, in which the nostrils are pierced, narrowed to tip; head and neck very scantily clothed with hairs, carunculated; tarsi without spurs or only an obtuse knob; toes moderate, hind toe elevated and short; tail lengthened and broad, or short and drooping.

5. FAMILY.—*Pheasants* (Phasianidæ). Bill curved to tip, upper mandible prolonged, culmen somewhat elevated at base; lateral margins rather undulating; nostrils covered by a hard tumid scale; cheeks more or less naked; head sometimes furnished with a fleshy crest, and pendulous wattles from base of lower mandible; wings rounded; tail long, broad, graduated or arched; tarsi with one or more spurs; hind toe elevated and short.

6. FAMILY. — *Grouse* (Tetraonidæ). Bill short, curved from base to tip; margins of upper mandible arched; nostrils covered by a hard scale, sometimes partly concealed by the feathers; tarsi sometimes clothed with feathers, with or without spurs; hind toe short and elevated, or wanting; tail lengthened or short.

7. FAMILY.—*Plover-Quails* (Pedionomidæ). Bill rather slender, compressed, culmen slightly

elevated and curved towards tip, nostrils placed in a long groove, covered by a scale; lower part of tibiæ sometimes bare; tarsi generally lengthened, covered in front with transverse scales; hind toe generally wanting, when present short and elevated; back much arched; tail very short.

8. **Family.**—*Tringoid-Grouse* (Thinocoridæ). Bill short, rather broad at base, compressed to tip, culmen curved to tip; nostrils fleshy; wings long and pointed; tail short, rather broad and rounded; tarsi short, strong, and covered in front with transverse scales, or wholly with reticulated scales, hind toe very short.

9. **Family.**—*Sheathbills* (Chionidæ). Bill rather short, strong, compressed, base of upper mandible invested by a folded horny sheath covering nostrils; orbits partly encircled by a warty skin; wings rather long; tail of moderate length and even; tarsi very strong and covered with small rough scales.

10. **Family.**—*Tinamous* (Tinamidæ). Bill rather lengthened, not stout, slightly curved, somewhat depressed at base, which is covered by a membrane, frontal feathers sometimes advancing to aperture of nostrils; wings short and concave; tarsi covered in front with large scales; hind toe small or wanting; tail rudimentary.

VI. ORDER.—Running-Birds (Struthiones).

Legs long, fitted for running; wings generally rudimentary; clothed with feathers of a peculiar character.

1. Family. — *Ostriches* (Struthionidæ). Stature large; bill broad, depressed; nostrils placed in a large membranous groove; head and neck sometimes destitute of feathers, the former surmounted by a crest, the latter wattled; wings rudimentary; tarsi long and very strong, covered with broad scales, two or three in number; claws blunt.
2. Family.—*Ki-wis* (Apterygidæ). Bill long, slender, curved and grooved, very hard; nostrils small and placed at tip; tarsi rather short, strong; hind toe small and armed with a long acute claw; wings rudimentary, concealed by the feathers; tail none.
3. Family.—*Bustards* (Otididæ). Bill rather lengthened, broad at base, compressed towards tip, culmen straight for a portion of its length, then curved to tip, lateral margin of upper mandible undulating; emarginate at tip; nostrils large, placed in a membranous groove; tarsi long, covered with small scales; toes short, three in number; wings long and pointed; tail broad and rounded.

VII. ORDER.—Wading-Birds (Grallæ).

Legs long and slender, with lower part of tibiæ naked; bill often long and more or less slender.

1. **Family.**—*Plovers* (Charadriidæ). Bill variable in length, basal half soft and weak, apical part hard, with culmen generally somewhat elevated and curved to tip, which is more or less pointed; nasal groove deep, extending about half the length of the bill; tarsi more or less lengthened; toes connected at their base by a membrane, hind toe small or wanting; wings long and pointed; tail generally broad and even.

   The Oyster-catchers (*Hæmatopodinæ*) have the bill long, much compressed, and truncate.

2. **Family.**—*Herons* (Ardeidæ). Bill long, more or less slender, compressed, pointed; long much depressed and spatuliform, long slender and arcuated, or short with culmen curved to tip; tarsi long and slender; toes lengthened and furnished with acute curved claws; neck long and slender; back generally much arched; wings usually rounded; tail mostly short and even.

3. **Family.**—*Snipes* (Scolopacidæ). Bill more or less lengthened, slender, generally obtuse, straight, arcuated or recurved, soft for a considerable portion of its length; culmen sometimes curved at tip; upper mandible grooved to near tip, which is sometimes dilated; nostrils basal, placed in groove; tarsi variable in length, slender; toes more or less connected by a membrane; wings

long and pointed; tail generally short and rounded.

4. FAMILY.—*Screamers* (Palamedeidæ). Bill not very long, rather slender with culmen towards tip somewhat elevated and curved, or stouter and the culmen elevated at base and curved to tip; upper mandible rather prolonged; nostrils placed near middle of bill; tarsi long, sometimes very stout; toes very long and armed with long, acute, and straight or curved claws; wings moderate and armed with an acute or blunt spur; tail generally short.

5. FAMILY.—*Rails* (Rallidæ). Bill varying in length, compressed, culmen sometimes advanced and dilated, shield-like on forehead, always more or less curved at tip, nostrils placed in a groove towards middle of bill; toes long, sometimes margined on each side by a lobed dilatation of the skin; wings usually rounded; tail generally very short; body compressed.

VIII. ORDER.—AQUATIC BIRDS (Anseres).

Tarsi generally short, feet webbed; plumage close and dense.

1. FAMILY.—*Ducks* (Anatidæ). Bill covered by a membrane, elevated and compressed at base, depressed towards tip, and often more or less dilated; tip of upper mandible furnished with a nail; lateral margins furnished with

lamellar plates or serrated; tarsi generally short; toes connected by a membrane, hind toe free.

2. FAMILY.—*Divers* (Colymbidæ). Bill generally lengthened, compressed, pointed; tarsi much compressed; toes webbed or margined by a lobed dilatation of skin; wings pointed; tail very short or wanting; legs placed far back causing the bird to stand erect; neck slender, and lengthened.

3. FAMILY.—*Auks* (Alcidæ). Bill varying in length, often short, sometimes greatly compressed, culmen curved to tip, where upper mandible is slightly prolonged and inflexed; tarsi short and compressed; toes connected by a web, hind toe generally wanting; legs placed far back compelling an erect position when standing; tail feathers short and stiff; wings small and pointed, sometimes useless for flight; neck short and thick.

4. FAMILY.—*Petrels* (Procellariidæ). Bill rather long, straight, compressed, deeply grooved; upper mandible hooked; nostrils tubular; tarsi usually shorter than middle toe; toes webbed; wings long and slender.

5. FAMILY.—*Gulls* (Laridæ). Bill of moderate length, compressed, culmen straight for half its length, then curved to tip, which is acute; nostrils lateral, linear, placed about middle of bill; tarsi about the length of the middle toe; toes connected by a web, hind toe ele-

vated, sometimes very small; claws curved, sometimes very acute; wings long and pointed. The Skimmers *(Rhynchopinæ)* have lower mandible much longer than upper, and both suddenly compressed from base, and truncate.

6. FAMILY. — *Pelicans* (Pelecanidæ). Bill long, strong, pointed or hooked, lateral margins sometimes serrated; nostrils basal; tarsi short; all the four toes connected by a membrane; throat sometimes furnished with a dilatable pouch; wings long and pointed.

REPTILES.

The Reptiles, though not a very extensive group, present numerous points of great interest to the observant naturalist. Among them is to be found extreme diversity of external configuration, more so, perhaps, than in any other class of vertebrate animals. They include, among their varied forms, the gliding, hissing Serpent; the lively, active Lizard; the gigantic Crocodile; and the huge, unwieldy Turtle. Yet all these, though differing so much from each other in outward appearance, nevertheless possess a sufficient number of characters in common as to enable them to be united into one class. They are all cold-blooded creatures, and their movements are more sluggish than in either of the preceding classes;

the size of the brain and the amount of nervous matter is proportionally small, and their motions appear to proceed less from a common centre. They abound more in the warmer regions of the globe, where they remain lively all the year through, while in colder climes they become torpid during the winter months. The typical family of Reptiles is that of Lizards, in which the essential characteristics are well marked, and the individuals belonging to which attain to a more advanced state of development, generally speaking, than any others of the group. Many possess an amount of beauty capable of arresting the attention of any ordinary observer, their hues being rich and varied, and their actions graceful and agile. Few exceed in these particulars the handsome Green Lizard, so abundantly met with in the South of Europe, and which may there be seen basking on sunny banks, darting from spot to spot, or retreating hastily under some friendly rock to escape the gaze or the grasp of some too curious stranger. Presenting a striking contrast to this, is a wild, forbidding-looking reptile, aptly named by Gray "*Moloch horridus*," which, with its short, broad, dark-coloured body, armed at all points with sharp, bristling spines, and with an unshapely head, appears to be the incarnation of some mischievous imp or unclean spirit. The Skinks, with their curiously-rounded toes, the Blind-Snakes, with their extremities concealed under the skin, the limb-less Serpents progressing on their belly, or the strange Amphisbænians, so named from being believed to advance by either end, also present singular and wonderful gradations. The Tortoises, lacustrine and terrestrial, with rounded bodies and more sluggish motions, appear, at first sight, widely removed from the more slender and active creatures to which we have just alluded; yet these, as well as the marine Turtles which propel themselves through the water by means of their fin-shaped extremities, alike agree in presenting all the essential characters of the class. New-Holland, so prolific in novel forms, supplies a Tortoise *(Chelodina)*, whose long, swan-like neck, bearing a small head, with fierce-looking eyes, almost carries us back in fancy to those remote times when the somewhat similarly-constituted *Plesiosaurus* moved through primeval waters, of which animal this Australian species would seem to be a living representative. The Chameleon, so renowned in story and in fable, is one of the existing wonders of this class, and still condescends to exhibit to the amazed beholder its seemingly magical power of changing its complexion. The origin of the belief in some of the fabulous creatures of antiquity, as the Dragon or the Basilisk, may be traced to forms which prevail even in these matter-of-fact-days. The latter name is still retained by an elegant tropical Lizard, which has, however, lost the dread power of its namesake of old, and we still possess a Flying-Dragon, which, though terrible no longer, flits about with its wing-like appendages from tree to tree among the forests of the Indian Archipelago. A mystical member of this alliance is the semifabulous monster of our own times, the celebrated Sea-Serpent, whose existence, though repudiated by all sufficiently learned to be sceptical, still forms part of the creed of honest Jack-tars and other dwellers on the mighty deep, and which is reported still to pay an annual visit to the Scandinavian fishermen on the shores of Norway.

The flesh of many reptiles is eaten by the inhabitants of the countries in which they are found, and that of the turtle forms a very important item in the bill of fare of English epicures. In a really economical point of view they are not of much importance, the principal product which they yield being "Tortoise-shell," so extensively employed in the arts and manufactures.

Though this class is now far from numerous, yet at one period of the earth's history Reptiles formed its principal inhabitants, and in size exceeded anything of the kind now extant. Our crocodiles and boa-constrictors, the largest now in existence, were far outvied by the Saurians, whose fossil remains so abound in the lias and oolitic formations, among which the *Megalosaurus* and *Ichthyosaurus* may be noted for their almost colossal proportions; while the *Plesiosaurus*, with its elongated neck, is no less remarkable for its singular fish-like contour. Among the terrestrial species of that era were the gigantic *Iguanodon*, and a strange, flying Lizard, named the *Pterodactylus*, which, with expanded wings, Bat-like, flitted through the air.

All true Reptiles are air-breathing, and respire by means of lungs, to which rule those which are aquatic form no exception, as they must obtain their supply of fresh atmospheric air by coming to the surface of the water. As far as regards man the majority are harmless, though some, as the Crocodiles and Alligators, will occasionally attack him; and others, as the venomous Serpents, are justly feared, from the deadly nature of the secretion from their poison glands.

In the following list, the arrangement followed is that given by Dr. Gray in his Catalogues of the Reptiles of the British Museum, which seems to be at once a convenient one, and also adapted to the present extent of our knowledge. The descriptions therefore of the orders and families, have been chiefly condensed from these valuable works.

III. CLASS.—REPTILES (Reptilia).

Air-breathing; cold-blooded; skeleton bony; integument clothed with horny plates, or imbricated scales, which are covered with a thin and often deciduous epidermis; lungs cellular; heart trilocular; no transformation after birth; reproduction oviparous.*

I. *SUB-CLASS.*—SCALY-REPTILES (Squamata).

Body covered with overlapping scales; skull formed of separate bones; tongue free, elongate, nicked at tip, often extensile; vent a cross slit;

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* With some exceptions, as in the case of the "Viviparous Lizard" *(Zootoca vivipara)* of our own country.

generative organs bifid; oviparous, rarely ovoviviparous; eggs when deposited with a more or less coriaceous shell.

I. ORDER.—Lizards (Sauria).

Mouth not dilatable; jaws toothed; lower jawbones united in front by a bony suture; eyes generally with distinct eyelids; drum of ear generally distinct, exposed; limbs 4, distinct, rarely rudimentary; toes clawed; body elongate, rounded, covered with imbricated or granular scales; tail elongate, tapering, rarely prehensile, generally covered with whorls of scales; eggs with hard skin.

I. *SUB-ORDER.*—Slender-tongued Lizards (Leptoglossata).

Tongue flat, elongate, and bifid.

1. TRIBE.—Cyclosaurians (Cyclosauria).

Scales of belly square, in cross bands; of back and tail rhombic and imbricate, or circular and sub-granular, in cross-rings; of sides generally granular; tongue elongate, flattened, base sometimes sheathed, generally free, with two elongate, cylindrical, horny tips; tail elongate, with whorls of scales, generally conical, tapering, sometimes compressed, with two elevated crests above.

A. *Head with small many-sided shields. Tongue sheathed at base. Sides flattish, granular.*

1. Family.—*Monitors* (Monitoridæ). Head-shields minute, flattish, polygonal; tongue retractile; scales small, roundish, in cross rings,

those of sides like those of back. Legs 4, strong. Toes 5-5, compressed, unequal.—Thighs poreless.

2. Family.—*Caltetepons* (Helodermidæ). Head depressed; head-shields many-sided, convex; muzzle rounded; femoral pores none; scales of back and sides oblong, 6-sided, very convex; of belly oblong, rather convex; tail round, with oblong convex scales above, and flat, elongate, thin plates beneath; legs 4, strong; toes 5-5, curved.

B. *Head with large, regular shields. Tongue mostly free at base.*

3. Family.—*Teguexins* (Teidæ). Head pyramidical: shields regular, many-sided; teeth solid, rooted; tongue free, elongate, flat; scales of back granular or keeled, rhombic; sides flat, scales small, granular; throat scaly, with a double collar.

4. Family.—*Lizards-proper* (Lacertidæ). Head pyramidical; shields regular, many-sided; throat scaly, often with a cross fold in front, and a collar of larger scales behind; tongue elongate, flat, long-forked; teeth hollow, rooted; scales granular or rhombic, keeled; sides flat, scales small, granular.

5. Family.—*Cordyles* (Zonuridæ). Head pyramidal or depressed; shields regular, many-sided; tongue flat, nicked at tip; scales of back and tail large, rhombic; sides with a distinct

longitudinal fold, with small granular scales; ears distinct; eyes with two valvular lids; limbs 4, strong, rarely wanting, or hid under skin.

6. Family.—*Short-legged Lizards* (Brachypodidæ). Head-shields regular, many-sided; temples shielded.—Tongue squamose, with two small pointed-tips; palate toothless; nostrils lateral; eyelid distinct; ears hidden; limbs 4, rudimentary; femoral pores none; body elongate, cylindrical; lateral fold indistinct; scales of back and tail 4 or 6-sided, imbricate, in cross bands,—of belly square.

7. Family.—*Argalias* (Argaliidæ). Head-shields regular; cheeks, eyelids, and eye-brows shielded; lower eyelid scaly, opaque; nostrils lateral, anterior; body subcylindrical; sides rounded, smooth; scales in thin, smooth, imbedded, transverse series, scarcely overlapping; of back, sides, and tail 4-sided, longer than broad, in alternating series,—of belly and under side of tail in longitudinal series,—of limbs oblong; limbs rather short, strong; femoral pores distinct, numerous; claws short, compressed; tail cylindrical, tapering.

8. Family.—*Anadias* (Anadiidæ). Head-shields regular, many-sided; ears distinct; eyelids distinct; scales of back and sides squarish, 6-sided, thin, smooth, imbedded, in alternating cross rings, of belly 4-sided, of tail 4-sided, in rings, one behind another, forming

longitudinal series; sides rounded; scales of throat square; toes 5-5, unequal, clawed; nostrils in facial ridge; temples shielded; femoral pores numerous.

9. Family.—*Iphisas* (Iphisidæ). Head and chin shielded; ear open, circular; sides rounded; scales of back, belly, nape, and throat smooth, broad, 6-sided, transverse, forming a single series on each side of tail, narrow, lanceolate, elongate, regularly keeled, in rings alternating with each other.

10.—*Chirocoles* (Heterodactylidæ). Head-shields regular, many-sided; tongue scaly; palate toothless; nostrils lateral; eyelids distinct, lower transparent; collar double; ears hidden; body and tail elongate, subcylindrical; scales of back, sides, and tail slender, 6-sided, lanceolate, keeled, imbricate, in regular rings, those of neighbouring rings alternating with each other, of belly square, smooth, imbricate, in longitudinal series; legs 4, short; femoral pores numerous, in the centre of a scale.

11. Family.—*Ring-tailed Lizards* (Cercosauridæ). Head-shields many-sided; upper eyelids very short; ears distinct; collar rather distinct; body subcylindrical; sides rounded; scales of back, sides, and upper part of tail ringed, large, keeled, in longitudinal series; of belly and tail beneath flat, square; legs 4, moderate; toes 5-5, unequal, smooth beneath; tail rounded.

12. FAMILY. — *Anguine-Lizards* (Chamæsauridæ). Head-shields many-sided; tongue nicked; palate toothless; temple scaly; eyelids distinct, lower scaly; body subcylindrical, elongate, all except head covered with rings of elongate keeled scales in longitudinal series; limbs rudimentary; ears distinct; no lateral groove.

2. TRIBE.—GEISSOSAURIANS (Geissosauria).

Scales of belly, back, and sides rounded, quincuncial, imbricate; sides rounded, with scales like those of back; tongue narrow, short, flat, and slightly nicked; head with regular many-sided shields; neck not contracted; body fusiform or sub-cylindrical; præanal pores mostly none.

A. *Eyes distinct, exposed; eyelid rudimentary; head conical.*

13. FAMILY.—*Gape-eyed Skinks* (Gymnophthalmidæ). Body fusiform; ears distinct; eyelid circular, immoveable; nostrils lateral in a nasal shield; teeth conical, simple; palate toothless; tongue scaly, nicked; limbs 4, weak, unequal; femoral pores none.

14. FAMILY.—*Pygopodes* (Pygopodidæ). Body cylindrical, elongate; ears distinct; eyelid immoveable, scaly; head pyramidical, shielded; nostrils oblong; teeth conical, simple, palate toothless; tongue flat, scaly in front, velvety behind, nicked; ventral shields in 2 or 4

series; tail with a central series of larger shields; limbs 2, posterior, rudimentary.

15. FAMILY.—*Aprasias* (Aprasiidæ). Body and tail cylindrical, tapering; ears hidden; nostrils small; head small, half-conic, shielded; muzzle rather produced; eyelids edged with small scales; pupil round; scales of back and belly hexagonal; limbs none; præanal pores none.

16. FAMILY. — *Scaly-cheeked Lizards* (Lialisidæ). Body elongated, sub-cylindrical; head elongated, depressed; head-shields subimbricate, scale-like; cheeks scaly, muzzle flattened; eyelid scaly, pupil elliptical, erect; ears distinct; scales oval, smooth, imbricate; belly with 2, tail with 1 series of large shields; limbs 2, posterior, short; series of præanal pores in front edge of a scale.

B. *Eyes distinct; eyelids distinct, valvular; head conical.*

17. FAMILY.—*Skinks* (Scincidæ). Body fusiform, or sub-cylindrical; head sub-quadrangular, shielded; nostrils lateral; rostral plate moderate, triangular; limbs 4, more or less strong, sometimes hidden; femoral pores none.

18. FAMILY.—*Snake-Lizards* (Ophiomoridæ). Body cylindrical, elongate; head shielded, muzzle rather produced; nostrils lateral; teeth straight, conical, blunt; palate not toothless; tongue flat, scaly, feebly nicked; ears hidden; rostral moderate, triangular; limbs none external; scales smooth, 6-sided.

19. **Family.**—*Seps* (Sepidæ). Body fusiform or subcylindrical, elongate; tongue flat, scaly, nicked; teeth conical, simple; palate toothless; rostral rather large, square; scales smooth; toes simple, unequal, clawed; tail conical, pointed.

20. **Family.**—*Acontias* (Acontiidæ). Body cylindrical; head small, shielded; muzzle conical; upper eyelid small or wanting; ears very small or hidden; tongue scaly, imbricate, nicked; rostral large, cup-like; scales smooth; limbs 4, very short, or none; femoral pores none

C. *Eyes hidden under skin.*

21. **Family.**—*African Blind-Lizards* (Typhlinidæ). Body and tail cylindrical; head conical; chin with a cup-like shield; rostral rather large, cup-shaped; ears hidden; scales smooth, equal, 6-sided; limbs 2, posterior undivided, or none.

22. **Family.**—*Blind-Lizards* (Typhlopidæ). Body cylindrical, sometimes larger behind; head broad, depressed; nostrils lateral; tongue elongate, flat, forked; mouth small, lineate, inferior; rostral elongate; scales 6-sided, smooth.

23. **Family.**—*Rough-Tails* (Uropeltidæ). Body cylindrical; head conical, compressed; nostrils roundish, lateral; tongue elongate, flat, forked; eyebrow-shields none; rostral produced, erect, convex; scales 6-sided, smooth; vent with three scales in front.

II. *SUB-ORDER.*—THICK-TONGUED LIZARDS (Pachyglossata).

Tongue thick, convex, attached to the gullet at the base.

3. TRIBE.—NYCTISAURIANS (Nyctisauria).

Scales of belly small, rhombic, imbricate; of back and sides granular; tongue thick, short, convex, slightly nicked; eyes nocturnal; eyelids circular, not connivent; pupil linear, erect; body depressed; toes sub-equal, lamellar beneath.

24. FAMILY.—*Gekkoes* (Gekkonidæ). Body depressed, sometimes fringed on the sides; pupil linear, rarely round; eyes nocturnal; scales of belly small, rhombic, imbricate; of back and sides granular; feet for walking; toes generally dilated.

4. TRIBE.—STROBILOSAURIANS (Strobilosauria).

Scales of belly small, rhombic, imbricate; of back and sides, imbricate; tongue thick, short, convex, slightly nicked; eyes diurnal, eyelids valvular, pupil round; feet for walking, toes unequal, compressed; tail with more or less distinct whorls of scales.

25. FAMILY.—*Iguanas* (Iguanidæ). Body compressed, sub-trigonal, or depressed; toes simple or dilated; teeth round at root, dilated and compressed at tip, toothed on the edge, placed along inner side of jaws, just below the edge.

26. FAMILY.—*Crested-Lizards* (Draconidæ). Body compressed; tongue short, depressed, apex entire, or slightly nicked; eyelids connivent; feet for walking; thumb anterior and internal; great toe of hind foot occupies same position; teeth on edge of jaw-bones; live in trees.

27. FAMILY.—*Spinous-Lizards* (Agamidæ). Body depressed; tongue short, depressed; eyelids valvular; scales of back imbricate; throat with a cross fold; toes free, unequal; terrestrial.

5. TRIBE.—DENDROSAURIANS (Dendrosauria).

Scales of belly, sides, and back, granular; tongue elongate, sub-cylindrical, worm-like, very exsertile; eyes globular, very mobile, with a small, central, round opening; toes equal, united into two opposing groups; ears hidden.

25. FAMILY.—*Chameleons* (Chamæleonidæ). Body compressed; scales generally granular; tail prehensile; teeth implanted on edge of jaw-bones; males distinguished by thickness of base of tail; slow-moving animals.

The arrangement of the toes of the Chamelions into two opposing groups is beautifully adapted to their habits, enabling them to take a firm hold of what they crawl along, and almost quite to encircle small branches. The division of their toes is rather singular, on the fore feet two toes being external and three internal, while in the hind feet the numbers are reversed, three being external and two internal, so that their whole number of twenty toes may be looked on as arranged in four longitudinal series, each containing five.

II. ORDER.—SERPENTS (Ophidia).

Mouth dilatable; facial bones moveable; jaws toothed; lower jaw bones united by ligaments in in front; eyes without eyelids; external ears none; tongue very long, retractile into a sheath at its base, apex forked, very long, slender, tapering; limbs none, or only rudimentary; one lung very large, the other very small or rudimentary.

I. *SUB-ORDER.*—VENOMOUS-SERPENTS (Viperina).

Jaws weak, upper one toothless, with distinct poison-fangs in front, lower toothed; head large behind; crown with scales, rarely with shields; hinder limbs not developed; eyes lateral; nostrils apical, lateral.

1. FAMILY.—*Rattle-Snakes* (Crotalidæ). Face with a large pit on each side, between eye and nostril; crown covered with scales or small shields; upper jaw with long fangs; belly-shields broad, band-like; anal spurs none; viviparous.
2. FAMILY.—*Vipers* (Viparidæ). Face without sub-orbital pits; rostral shields broad, band-like; scales mostly keeled; tail short, tapering.

II. *SUB-ORDER.*—WATER-SERPENTS (Hydrina).

Jaws strong, toothed; fangs moderate, intermixed with maxillary teeth; eyes and nostrils superior; pupils small, round; hind-limbs not developed; ventral shields narrow, hexagonal, or band-like. Live in water.

3. **FAMILY.**—*Salt-Water Serpents* (Hydrophidæ). Head usually small, with shields or scales; belly keeled, with two rows of small scale-like shields, often united together; nostrils valvular; tail mostly broad, compressed; colours chiefly green or yellow. Can live only for a short time out of water. Live in the sea or in salt lakes. Venomous.

The genus "*Achrocordus*" is included with this family by Gray, but its tail is conical. It inhabits rivers, and in Manilla and Java, is considered by the inhabitants as quite innocuous.

4. **FAMILY.** — *Fluviatile-Serpents* (Homalopsidæ). Belly rounded, with more or less broad band-like shields; head moderate, often depressed, mostly shielded; tail conical, tapering; eyes and nostrils small; colours mostly sombre. Inhabit rivers and ponds.

III. *SUB-ORDER.*—HARMLESS-SERPENTS (Colubrina).

Jaws strong, both toothed; no poison-fangs; head moderate or indistinct; crown at times with regular shields; tongue very extensible.

5. **FAMILY.**—*Boas* (Boidæ). Hinder-limbs rudimentary, spur-like; nostrils lateral; eyes lateral, pupils oblong; ventral-shields narrow, trans-

verse, band-like, often 6-sided; tail short, conical, generally prehensile. Live in marshy places.

6. FAMILY.—*Serpents-proper* (Colubridæ). Vent without spur-like feet; head usually shielded; belly with broad band-like shields; nostrils apical, lateral, open; tail conical, tapering. Live chiefly in dry places.

7. FAMILY.—*Crown-Serpents* (Coronellidæ). Size moderate or small; body compressed, often angular; scales generally smooth, temporal-scales large; tail conical, rather long. Inhabit dry or humid regions.

8. FAMILY.—*Short-Headed Serpents* (Oligodontidæ). Size small; head short, narrow, obtuse; palatine teeth wanting; colours mostly bright.

9. FAMILY. — *Wood-Serpents* (Herpetodryadidæ). Form slender; head elongate; tail much lengthened; mouth very wide; scales small, partly carinated, in oblique series. Colours chiefly green. Live in woods.

10. FAMILY.—*Tree-Serpents* (Dendrophidæ). Form elongated; trunk compressed; tail slender, in some angular; head small, not broader than body; pupils mostly orbicular; colours generally vivid.

11. FAMILY.—*Forest-Serpents* (Dipsadidæ). Body somewhat lengthened, vigorous, compressed; head thick, obtuse, broader than body; pupils often vertical; row of scales along spine larger than those of sides.

II. *SUB-CLASS.*—Shielded-Reptiles (Cataphracta).

Body covered with square imbedded plates, generally forming a dorsal and a ventral shield; bones of skull thick, united into a hard mass; tongue short, affixed to mouth, scarcely exsertible; jaws united into a solid mass; mouth not dilatable; vent round or linear, plaited; oviparous; egg with a hard shell.

I. ORDER.—Chelonians (Chelonia).

Body short, depressed, enclosed in a case, formed by two shields united at their margins; jaws toothless; upper bill covers lower like a box; eyes with distinct eyelids; drum of ear visible; legs short, thick; tail conical; vent circular.

1. Family.—*Land-Tortoises* (Testudinidæ). Head ovate, shielded; jaws naked; nostrils apical; neck retractile; feet short, club-shaped; claws 5-4, or 4-4, blunt; shell very solid, thick, ovate; tail short, thick; slow moving.
2. Family. — *River-Tortoises* (Emydidæ). Head rather depressed; jaws naked; nostrils apical, small; feet depressed, palmate; toes 5-5, or 4-4, mostly webbed to the claws; claws sharp; tail conical, shielded beneath; thorax generally depressed; pelvis united to vertebræ only; sternal shields 11 or 12; egg oblong, white; carnivorous; rapid.
3. Family. — *Long-necked Tortoises* (Chelydidæ). Head much depressed, broad; nostrils elongate, tubular; eyes superior; jaws horny;

neck long, broad, contractile; feet webbed; toes 5-5; claws 5-5, 5-4, or 4-4, elongate, acute; shell depressed; pelvis attached to vertebræ and sternum; sternal shields 13.

4. FAMILY. — *Soft-Tortoises* (Trionycidæ). Head flattened, ovate; eyes small, superior; jaws horny, with dependant fleshy lips; nostrils elongated into a thin cylindrical trunk; neck long, contractile; feet palmate, short, strong; toes 5-5, short, expanded, webbed; two outer clawless; claws 3-3, acute; tail short, conical, simple; bones covered with a soft skin with a flexible margin; pelvis attached to vertebræ; eggs spherical.

5. FAMILY.—*Turtles* (Cheloniidæ). Head globose, shielded; nostrils rather tubular; jaws horny, naked; neck short, sub-retractile; feet very long, not retractile, compressed, fin-shaped; toes depressed, with flat claws; tail short, thick; shell low, cordate, with a defined bony margin.

II. ORDER.—EMYDOSAURIANS (Emydosauria).

Head large, covered with a thin skin; ears linear; gape wide; tongue short; jaws with a single series of conical teeth; nostrils small, anterior; eyes small; body fusiform, covered with square bony plates in longitudinal lines; limbs 4, free; tail compressed vent linear, longitudinal.

1. FAMILY.—*Gavials* (Gavialidæ). Muzzle very long,

slender, sub-cylindrical; teeth nearly equal; feet webbed. Old World.

2. Family.—*Crocodiles* (Crocodilidæ). Body fusiform; muzzle oblong, depressed; teeth unequal; lower canines fit into notches in edge of upper jaw; feet webbed. Old World chiefly.
3. Family —*Alligators* (Alligatoridæ). Muzzle broad, obtuse; teeth unequal; lower canines fit into a pit in edge of upper jaw; feet scarcely webbed. New World.

III. ORDER.—Amphisbænians (Amphisbænia).

Body elongate, cylindrical, naked, with square imbedded plates in cross rings; tail short, continuous, blunt; tongue flat, not sheathed, nicked; eyes small, hidden; eyelids none; ears hidden; mouth small; jaws not extensile; feet none, or rarely in front; skull very solid; vent rather transversely plaited.

1. Family.—*Trigonophes* (Trigonophidæ). Teeth on edge of jaws, nearly united at base, unequal, conical, rather compressed; nostrils lateral, small, oval; præanal pores none; limbs none.
2. Family. — *Double-Walkers* (Amphisbænidæ). Teeth on inner side of jaws, conical, simple, pointed; nostrils lateral, small; nape with a longitudinal groove; limbs none; præanal pores distinct; tail short.
3. Family. — *Lepidosternons* (Lepidosternidæ). Teeth on inner side of jaws, conical, simple,

pointed; nostrils lateral, small, inferior; chest covered with large and differently shaped shields from rest of body; limbs none; præanal pores none; tail short, truncate.

4. FAMILY.—*Chirotes* (Chirotidæ). Teeth on inner edge of jaws, conical, recurved, simple, pointed, unequal, separate; limbs 2, anterior, short, weak; toes 5, sub-equal, one clawless; præanal pores distinct; tail short, cylindrical.

AMPHIBIANS.

Until a recent period Amphibians were, by systematic writers, included under the head of Reptiles, constituting the Linnæan order of Batrachians; but a more careful and attentive study of their development and structure, led to their being established as a separate class.* To the popular mind most of the members of this tribe are objects of the greatest abhorrence, whereby many an unfortunate toad has been sacrificed at the shrine of vulgar prejudice. Formerly they were subjects of even more intense detestation, so much so as to be commonly connected with what was then looked on as a deadly crime, viz., witchcraft; and Shakspere mentions, among the contents of the witches' cauldron, not merely the persecuted toad, but likewise

"Eye of newt, toe of frog."

Nay, to such an extent was this belief carried, that many an ancient crone, who, in a blazing tar-barrel, expiated at once her own ugliness and her supposed dealings with the evil one, was held to have her familiar spirit near her, encased in the outward form of some hateful reptile.

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* By Latreille. *Vide* "Nouveau Dictionnaire d'Histoire Naturelle," 1re. edition. 1804.

But to the more enlightened understanding of the present age, Amphibians, though constituting by far the smallest class of vertebrate animals, have been shewn to present a vast number of singular and curious facts in their history, and in their habits, so as to yield to none in the interest they excite in the mind of the Zoologist. The most remarkable point connected with their development is, that they all undergo transformation after birth, being in early life entirely aquatic, respiring by gills, and at that period in most respects closely allied to fishes; while, after a time, they throw aside their ichthyic characters, their gills disappear, and they come out as inhabitants of dry land, breathing like all other terrestrians, by means of lungs. A few, however, seem to be so attached to early habits as never to be able to dispense with their gills, which, therefore, they retain for life, at times more for ornament than for use. One individual, is named "Proteus," after his celebrated namesake of antiquity, whom he tries to imitate in a small way, having the external appearance of an Amphibian, but the manners of a Fish. In the young, or tadpole state, they generally have a long tail, which in many, on arriving at maturity, becomes atrophied and finally disappears. Altogether they constitute a most interesting transition class, forming an intermediate, connecting link between Fishes on the one hand, and Reptiles on the other.

Amphibians can hardly be said to play an important part as far as man is concerned. The legs of the Edible-Frog *(Rana esculenta)* are eaten in France, where they are reckoned a great delicacy, fit only for the table of the opulent and dainty. In Mexico, another species, rejoicing in the almost unpronouncable name of "Axolotl," is at times an article of food; but from their small size and slight muscular development, they cannot afford much nourishment. The different viscera of the Toad, or at times the entire animal dry roasted, and reduced to powder, formed in the good old times an article of Materia Medica, and entered into the composition of many a wonderful nostrum, and in Sir Kenelm Digby's "Choice and Experimented Receipts in Physick and Chirurgery," the calcined powder is ranked along with the "fat of a buck rabbit," "powdered cockchaffers," &c., as capable of performing wonderful cures.

The Amphibians are here classified according to Professor Bell's plan, which seems to form a very natural arrangement. In the detail some of the families given may afterwards require to be united; but as many of the genera are yet but imperfectly understood, it has been considered advisable rather to amplify the sub-divisions, as more useful for obtaining a practical acquaintance with the class.

IV. CLASS—AMPHIBIANS *(Amphibia).*

Respiration atmospheric or aquatic; cold-blooded; skeleton bony; skin naked; lungs cellular; heart trilocular. Most (if not all) undergo a transformation or metamorphosis after birth; re-production oviparous; eggs with a soft shell.

I. ORDER.—Tail-less Amphibians (Anoura).

Body short, broad, depressed; feet wanting during tadpole state, afterwards 4, hinder ones longer; tail before metamorphosis long, compressed, afterwards wanting; tympanum open or hid.

1. Family.—*Frogs* (Ranidæ). Body tapering; head flat; hind legs extremely long; feet webbed; skin smooth; teeth on upper jaw and palate, minute; tympanum open.
2. Family.—*Toads* (Bufonidæ). Body bulky; hind legs slightly elongated; skin covered with warts; no teeth; tympanum open; avoid water.
3. Family.—*Palmate-Batrachians* (Dactylethridæ). Body short or oval; skin smooth or tuberculated; tongue wanting or distinct; teeth minute or partly absent; tympanum hid; hind feet broadly palmate; toes pointed.
4. Family.—*Cell-backed Toads* (Pipidæ). Body flattened horizontally; head triangular; tongue wanting; no teeth; skin granulated; tympanum hid. In females, during fecundation, skin of back forms cells, in which the eggs are hatched.

II. ORDER.—GILL-LUNGED AMPHIBIANS (Amphipneurta).

Body elongate, naked, smooth; feet 4, or 2 anterior only, rudimentary; toes short, weak; tail compressed, persistent; eyes small; eyelids none; respiration aquatic by means of persistent external branchiæ co-existing with rudimentary lungs.

1. FAMILY.—*Proteans* (Proteidæ). Legs 4, weak; tail compressed; gill-flaps distinct; gills large; palatine teeth in two long series on front edge of vomerine bones.
2. FAMILY.—*Sirens* (Sirenidæ). Legs 2, anterior; body sub-cylindrical; operculum none; gills small; palatine teeth in numerous cross series on vomerine bones.

III. ORDER.—LONG-TAILED AMPHIBIANS (Urodela).

Body elongate; tail long, persistent; limbs 4, weak; skin naked, smooth, or warty; ears hidden; respiration at first aquatic by external branchiæ, afterwards atmospheric by cellular lungs.

1. FAMILY.—*Salamanders* (Salamandridæ). Tail compressed or round (remains compressed in aquatic species); palatine teeth in two diverging series, one on inner posterior edge of each elongate palatine bone; sphenoid toothless; females of some viviparous.
2. FAMILY.—*Smooth-Salamanders* (Molgidæ). Head depressed; tongue large; tail rounded; palatine teeth in two converging series along outer and posterior edge of each elongate palatine bone; sphenoid toothless.

3. **Family.**—*Cross-toothed Salamanders* (Plethodontidæ). Skin smooth, rarely granular; palatine teeth in interrupted cross series in front of palate; sphenoid mostly toothed.

IV. ORDER.—Gill-less Amphibians (Abranchia).

Body elongate, formed for swimming; legs 4, rudimentary; tail compressed; respiration by means of lungs only; branchiæ rudimentary, internal.

1. **Family.** — *Menopomas* (Protonopsidæ). Body depressed; legs 4, strong, fringed on sides; toes 4 or 5; head depressed; palatine teeth in a transverse arched series.
2. **Family.** — *Amphiumas* (Amphiumidæ). Body very elongate; head oblong; lips thick; gape small; legs 4, rudimentary; neck with a foramen on each side; palatine teeth in two longitudinal diverging series.

V. ORDER.—Anguiform-Amphibians (Apoda).

Body slender, elongate, anguiform; feet none; tail almost wanting; branchiæ exist in the young state, disappear in the adult.*

1. **Family.**—*Blind-Newts* (Cæciliidæ). Skin smooth, wrinkled, with minute scales; head depressed; eyes very small, mostly concealed beneath skin; gill opening closed in adults.

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* *See* Müller in Oken's "Isis" for 1831, p. 710, or a translation by Mr. J. Hogg, in "Annals and Magazine of Natural History," vol. vii. 1841, p. 354.

FISHES.

Among the countless myriads of living creatures which inhabit the boundless domain of waters on our globe, none are more extensively diffused, or are more generally known to mankind than the finny tribes which we are now about to consider. They are found alike in salt and in fresh water; in the former, whether it be the vast ocean, or the more restricted sea, gulf, or inlet; and in the latter they equally pervade lake, river, streamlet, or pond. None of their fellow inhabitants of the deep present greater diversity in size, form, or general configuration, and none more abound in points interesting to the human race. As fully two-thirds of the earth's surface are occupied by water, it may be easily supposed that fishes form considerably the largest division of the vertebrate sub-kingdom. In the zoological scale they stand lowest in the list of vertebrate animals; that is to say, that although perfect in their own day and generation, they never attain to such an advanced state of general development as those classes which precede them. Their structure is admirably adapted for residence in the medium by which they are surrounded, as their bodies are nearly of the same specific gravity as the element which they inhabit, while their shape being that which offers the least amount of resistance, is no less beautifully calculated for favouring their powers of motion.

Being excluded from direct contact with atmospheric air, the oxygenation of their blood is dependant on the air dissolved in the water, which requires a special adaptation of their breathing apparatus. Accordingly we find that their permanent condition resembles that which is seen to exist in the young of the immediately preceding class of Amphibians, that is to say, they respire throughout their life by means of aquatic lungs or gills. By their agency the venous blood is exposed in a state of minute subdivision to the influence of streams of water, which is effected by the blood-vessels leading to them dividing again and again until they become nearly microscopic, in which state they are supported by a thin, delicate membrane, the whole being arranged as a series of plates or processes placed on what are named the branchial arches. In the greater number of fishes the water meant to supply these vessels enters by the mouth, and, being directed backwards, passes over them, and is finally expelled by the gill-opening under the gill-cover or *operculum*. Fishes are cold-blooded animals; that is, their temperature hardly exceeds that of the medium in which they live; yet to this there are some exceptions, as in the case of the "Bonito," mentioned by Dr. John Davey, whose temperature, he ascertained, surpassed that of the surrounding water by nearly ten degrees of Fahrenheit. Their chief propelling power is their tail, which acts by alternate strokes on either side, similar to the action of an oar in sculling. It is observed that their swiftness varies with the form of the tail; that those whose velocity is very great, such as the Mackarel, have this organ deeply forked and pointed; while in the more slowly-moving it is square or rounded. The projection backwards of water through the gill-aperture is also believed to have some effect in assisting their forward progress, which is also probably affected by the movements of their various fins. These last-named organs are among the most distinguishing objects of the class, and mostly consist of thin, delicate membranes, spread upon and supported by filaments or rays of more or less power and flexibility. These may be modified or divided in various ways, but an acquaintance with their names and situations is requisite, as by their differences families and genera are often separated. When complete they are seven in number; viz., one on the back, named the *dorsal;* two attached to the breast, the *pectoral;* two *ventral,* one on either side of the belly; one *anal,* situated along the under surface of the body; and one *caudal,* forming the tail. Of these the pectoral and ventral fins may be looked on as analogous to the fore and hind extremities of higher animals. The dorsal fin was formerly considered as influencing the perpendicular position of the fish in water, but from some experiments mentioned by Yarrell,* the idea would seem to be erroneous. The bodies of the greater number are covered with scales, which, however, vary much in their size, shape, and arrangement. These are attached by their anterior edge being left free posteriorly. Four principal forms are described, of which some knowledge is required, as they are frequently mentioned in the following classification. Agassiz has considered them of such importance that he has founded an arrangement on their differences, whereby fishes are divided into four orders, named respectively Ganoidians, Placoidians, Ctenoidians, and Cycloidians. *Ganoid* scales are so designated from their being covered with bright enamel; they are mostly thick and angular. Species of this order chiefly belong to extinct forms, the Sturgeons, and a few others, being the only living representatives. *Placoid* scales are composed of hard osseous matter, sometimes large, at other times reduced to small points, as when they form the prickly tubercles of the Skates. The third variety, or *Ctenoid*, derives its title from having the outer or posterior edge toothed like a comb. It is found occasionally in fossil genera, and is abundantly numerous among the Perches and other allied families. The last, or *Cycloid*, is that which is most characteristic of the fish of the present era, and is composed of smooth rounded layers of horny matter, entire at the margins.

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* 2nd ed., vol. i. p. 365.

The external configuration of fishes is extremely diversified. The most usual appearance is that of a cylindrical body, more or less pointed at the extremities. Others, as the common Cod, are broader anteriorly, and taper towards the tail. Some are short and broad, as the Chætodons ; others, as the Eels, long and narrow. Some present a considerable thickness of body, as the Salmons ; while others, like the Dealfish, are excessively thin. The mouth may be enormous as in the Fishing-Frog, or small, as in the File-Fishes; it may be situated beneath as in the Rays, or at the end of a long tube as in the Trumpet-Fish. Their teeth may be large, sharp, and numerous, as in the hungry Sharks; or they may be perfectly toothless. They may carry about with them long, gracefully waving rays, as the Gemmeous-Dragonet; be variously ornamented with leaf-like growths like the *Phyllopteryx;* or be armed at all points with sharp spines as the Diodons. Their exteriors may be hard and resisting, as those of the well-named Trunk-fishes; or soft and gelatinous, like the Lancelet or Myxine. Their nose may, as in some Breams, be snub, and not even so long as their chin; it may confer an air of impudence as in the Lesser-Weever; be a regular beak as in the Sea-Snipe; or be so prolonged like that of the Sword-Fish, as to make its possessor formidable even to the mighty Leviathan of the deep.

The eyes of fishes have been formed more to allow of ample power within a limited distance, than for extensive range of vision. In structure they vary from the simple eye-speck of the *Amblyopsis* to the singularly framed organ of the *Anableps.* They are most commonly situated one on either side of the head, but are sometimes brought more forwards. They may be far apart, as in the Hammer-headed Shark; be situated superiorly as in the star-gazing *Uranoscopus;* or, as in the Flounders and Skates, be placed both on one side of the head.

One striking internal peculiarity of fishes must here be noted, viz., the possession of a swimming-bladder, or "sound," as it is popularly termed. This organ, which is generally situated in the abdomen, laying close to the under surface of the back-bone, is, from various anatomical and physiological characters, which need not here be more than alluded to, considered to represent the lungs of air-breathing animals. It is found to exist in about three-fourths of the total amount of species, and is believed to be connected with their amount of buoyancy, as the greater number of those which do not possess it are ground fish. It is not found in the Sharks, as it might interfere with their power of turning on their side previously to seizing their prey. In a few it is thought to be subservient to the production of sound.

Among fishes remarkable for peculiar individual properties, may be mentioned the Flying-Fishes, which, by means of their extended pectoral fins are enabled to take flights, or leaps out of the water; and which, while so engaged, form one of the strange sights of tropical seas. The *Pegasi*, or Flying Sea-Horses, also at times appear above the surface. There are likewise wandering Fishes, which, imbued perhaps, with a strong spirit of curiosity, like the "Tree-Climber" *(Anabas testudineus)*, set out on their travels, leaving their native element, and presenting the singular sight of "fish out of water." Some fishes, as the Gurnards, are known to utter strange sounds. A species of *Pogonias*, named the the "Organ," or "Drum-fish," mentioned in the

"Account of the Voyage of the 'Samarang,'"* assembles in numbers, and holds a kind of "solemn aquatic concert;" and lastly, the electric fishes, such as the *Torpedo* and *Gymnotus*, resent the rude interference of strangers in a very unpleasant manner.

Fish are very important in an economical and commercial point of view, and are taken in great numbers for the sake of the food and other products they afford. Fisheries are encouraged and protected by all enlightened governments; and in our country, those more especially of the Cod, Ling, Coalfish, Torsk, Herring, Pilchard, Salmon, and Mackarel, afford employment to many thousands. The oil afforded by their livers is used for light by many northern races, and in Britain is also similarly employed in places along the sea-coast. Of late, that yielded by the Cod, Haddock, and Skate has been extensively administered as a medicinal agent in consumption, with wonderful results.

It is not, however, only in modern times or among civilized nations that fishes are sought after and prized; as food they have been in use from the earliest times. Whole tribes have been recorded by Pliny, Strabo, and other ancient writers, as Ichthyophagi, or fish-eaters; and among the most savage people, rude hooks and other implements for their capture are in constant employment. The spawning season varies in different species. Previous to it, some migrate from fresh to salt water, others from salt to fresh, in their endeavours to attain which many will encounter and overcome apparently insurmountable obstacles. In ascending streams, Salmon and Trout take often wonderful leaps, clearing thereby small rapids and falls. The former species leaps farther and higher than the latter, which is used to measure the size and strength of falls in some North American rivers, a Salmon leap being more considerable than a Trout leap. At present considerable attention is being paid to the artificial impregnation of fish-roe, a process which promises to prove of no little importance.

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* Adams' Nat. Hist. of the Voyage of H. M. S. "Samarang," p. 259.

The most simple and primitive division of fishes is into osseous and cartilaginous, according to the nature of the skeleton. This was done by Cuvier, who sub-divided the former from the nature and position of the fins. Agassiz, as before stated, proposed a classification founded on the shape and structure of the scales, which, however, being founded on one particular system, may be looked on as somewhat artificial. In the following arrangement, the orders have been taken from Professor Owen's modification of Müller's classification; while the descriptions of families are mostly from Cuvier and Swainson. The more comprehensive families of Müller and Owen, however perfect in a philosophical point of view, or however well adapted for a work including mention of genera, are not suited for our pages, as they would afford but little assistance to those most likely to require directions. The details have therefore been more amplified than they would otherwise have been. The terms "Endo-skeleton" and "Exo-skeleton," are employed in the sense in which they are used by Owen, the former meaning the vertebral centre, with the attached bones; and the latter implying the external, or what is often called the tegumentary covering of the body.

V. CLASS.—FISHES *(Pisces)*.

Live habitually in water; cold-blooded; respiration aquatic; skeleton bony or cartilaginous; body generally covered with scales; heart bilocular; no organ of prehension except mouth; flexure of spine principally lateral; reproduction oviparous.*

I. ORDER.—WIDE-MOUTHED FISHES (Plagiostomi).

Endo-skeleton cartilaginous, or partially ossified; exo-skeleton placoid; gills with 5 or more gill apertures; no swimming-bladder.

I. *SUB-ORDER.*—RAYS (Raiinæ).

Body horizontally flattened, and more or less discous; dorsal fins mostly on tail; a peculiar *(naso-pectoral)* cartilage, arising from nasal part of skull, extends towards or meets anterior part of crest of pectoral fin; branchial openings inferior.

1. FAMILY.—*Horned-Rays* (Cephalopteridæ). Muzzle with two horn-like processes; mouth before or beneath, very broad; teeth very small, in some wanting in upper jaw; tail as long, or longer than body, with a back-fin, and a spine.

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* With many exceptions, such as the 'Viviparous Blenny' *(Zoarces viviparus)* of our own shores.

2. FAMILY.—*Eagle-Rays* (Myliobatidæ). Head partially disengaged from pectorals; mouth transverse; teeth large, mosaic-like; eyelids wanting; tail long, with a back-fin on root, and a serrated sting behind.
3. FAMILY.—*Sting-Rays* (Trygonidæ). Head laterally enclosed by pectorals; teeth transversely elliptical; tail without any fin, or merely a low, vertical, cuticular hem, and with one or more sharp serrated spines.
4. FAMILY.—*Stingless-Rays* (Anacanthidæ). Teeth flat, transversely elliptical; tail without any fin, or with a small one on under side; no spine.
5. FAMILY.—*Skates* (Raiidæ). Body rhomboidal; tail depressed, slender, generally with a low terminal fin, and frequently with rows of small spines; skin smooth, or with small curved prickles; teeth flat, pavement-like, and pointed in males in spawning time.
6. FAMILY.—*Torpedos* (Torpedinidæ). Head very large and surrounded by pectorals, so as to form a circular disk; tail short, fleshy, depressed at base, cylindrical at extremity; mouth beneath; teeth pointed or flat.

Some members of this family are remarkable for their power of communicating at will powerful electric shocks. The organs whence these proceed are two in number, lodged on either side of the head, and encompassed by the gills, and the anterior borders of the pectoral fins. They consist of a mass of perpendicular, hexagonal columns, the ends of which are covered by the dorsal and ventral integuments. Each separate column, when recent, seems like a mass of clear trembling jelly; but consists of a series of delicate membranous plates, inclosed by a proper capsule, and separated from each other by a small quantity of limpid, albuminous fluid. Each half of this electric battery derives its nervous influence from one branch of the *trigeminal*, and four branches of the *vagus* nerves. The battery is thus vertical, and its plates horizontal, and the direction of the current is from above downwards, the dorsal surface being positive, and the ventral negative.*

7. FAMILY.—*Beaked-Rays* (Rhinobatidæ). Muzzle generally beaked and pointed; mouth undulated; teeth rounded or elliptical, in some broader than long, and longer on summit of undulations; body smooth; caudal fin bilobular, or cut obliquely, forming one lobe.

8. FAMILY.—*Saw-Fishes* (Pristidæ). Snout produced into a long, flat, osseous, saw-shaped blade, with teeth on the lateral edges; body flattened before, somewhat elongated posteriorly; skin with very small, flat, roundish, or six-cornered scales; mouth beneath.

II. *SUB-ORDER.*—SHARKS (Squalinæ).

Body elongated; tail fleshy, thick; branchial openings lateral; skull without frontal cartilage.

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* *See* "Swainson's Natural History of Fishes," vol. i., p. 178; and "Owen's Lectures on Comparative Anatomy," vol. ii., p. 212.

9. FAMILY.—*Hammer-headed Sharks* (Zygænidæ). Head excessively elongated on either side, so as to resemble a hammer; eyes remote, on the lateral ends; teeth serrated in adults.

10. FAMILY.—*Angel-Fishes* (Squatinidæ). Body flat above and below; mouth at fore end of snout; eyes on dorsal aspect; pectorals large, expanded anteriorly.

11. FAMILY.—*Greenland-Sharks* (Scymniidæ). Head flat, or compressed on sides, obtusely pointed; mouth beneath; dorsal fins without spines; gill-openings small.

12. FAMILY.—*Fox-Sharks* (Alopeciidæ). Snout short and rounded; teeth sharp, triangular; branchial openings small; tail unequally divided, upper lobe greatly prolonged, so as nearly to equal length of body.

13. FAMILY.—*Porbeagles* (Lamniidæ). Branchial openings large; spiracles very small; caudal fin crescentic, with a lateral keel; second dorsal and anal fin opposite each other.

14. FAMILY.—*True-Sharks* (Squalidæ). Body elongate, sub-cylindrical; head flat; mouth convex; teeth sharp-edged and pointed, mostly serrated; no spiracles in adult; dorsal-fins two, the second opposite anal fin; tail with a short under lobe.

15. FAMILY.—*Topes* (Galeidæ). Head flat; snout pointed or blunt; teeth in both jaws alike, flat or pointed, sharp-edged, sometimes serrated along one or both edges; spiracles small

or large; tail-pits indistinct, or wanting; under lobe of caudal-fin abortive in some; upper lobe notched.

16. Family.—*Spotted Dog-Fishes* (Scylliidæ). Snout generally obtuse; teeth tricuspidate; an anal and two dorsal fins; first dorsal opposite, or behind abdominal fins, never before; caudal none; spiracles distinct, generally large; colours lively.

17. Family.—*Piked Dog-Fishes* (Spinacidæ). Strong, sharp spine before each dorsal fin; skin rough in one direction; teeth in both jaws, mostly small, sharp, and cutting.

18. Family. — *Gray-Sharks* (Notidanidæ). Head flat; branchial openings six or seven, decreasing in size from first to last; one dorsal fin; tail-fin with a small under lobe, notched at the end, obliquely or directly truncated.

19. Family.—*Cestracions* (Cestraciontidæ). Branchial openings small; mouth at fore-end of snout; teeth pavement-like, anterior rows small and pointed; spiracles small; a prickle or sting before each dorsal fin; tail-fin short, with distinct under lobe.

II. ORDER.—False-Sharks (Holocephali).

Endo-skeleton cartilaginous; exo-skeleton as placoid granules; most of the fins with a strong spine for the first ray; gills laminated, attached by their margins; a single external gill-aperture; no swimming-bladder.

1. FAMILY.—*Chimæras* (Chimæridæ). Beak conical, in some ending in a foliaceous appendage; one external branchial opening, with five terminal sub-divisions; tail long, attenuated, and pointed; dorsals contiguous or remote; jaws furnished with hard plates instead of teeth.

III. ORDER.—AMPHIBIAN-FISHES (Protopteri).

Endo-skeleton partly osseous, partly cartilaginous; exo-skeleton as cycloid scales; pectorals and ventrals as flexible filaments; gills filamentary, free, swimming-bladder as a double lung, with an air-duct.

1. FAMILY.—*Lepidosirens* (Lepidosirenidæ). Body lengthened, or long, covered with scales; surface of body spotted; gill-filaments, in some, tripinnatifid; ribs 36 to 55 pairs. Inhabit marshy spots. Some remain torpid under ground during dry season.

Obs. The position of this singular creature in the animal kingdom has been keenly debated. It possesses in nearly equal proportion characters of an Amphibian and of a Fish, and it has accordingly been arranged by different authorities in one or other of these two classes. The former are held to predominate by Milne-Edwards, Bischoff, and Gray, while by Owen and by Müller the latter are believed to deserve the preference. In accordance with the views of these last, and until further enquiries finally decide the matter, it has been deemed advisable to continue it among the fishes. Its ichthyic claims have been favoured by Owen upon the "accumulative evidence of the structure of its dernal, dental, osseous, digestive, sensitive, and generative systems," but especially from the construction of the nasal cavity, and the microscopic character of the teeth and ossified parts of the endo-skeleton. Its amphibian alliance is again chiefly supported by the auricle of the heart being double, and by the large size of the blood discs. But three species are as yet known; one from the Amazon (*L. paradoxa*), one from the Gambia (*L. annectens*), and the third (*L. amphibia*), discovered by Dr. Peters, from the Quillemane marshes. Possibly these may represent genera, for which the names of *Lepidosiren*, *Protopterus*, and *Rhinocryptis* have been proposed to be respectively appropriated. For further information, *see* "Fitzinger," in "Wiegmann's Archiv," 1837, p. 232; "Lepidosiren paradoxa," von Johann Natterer, Annalen des Wiener Museums der Naturgeschichte, 1837, vol. ii. p. 165; "Owen," in Linn. Trans., vol. xviii.; "Owen's Odontography," vol. i. p. 166; "Milne-Edwards," in "Ann. des Scien. Natur.," Sept. 1840, p. 159, and in "Ann. and Mag. of Nat. Hist." vol. vi. 1841, p. 466; also papers, &c., by Jardine, Owen, Hogg, Müller, Smith, and Gulliver, in "Ann. and Mag. of Nat. Hist." vol. vii. 1841, pp. 21, 211, 358; xvi. 1845, p. 348; and ii. 1848, p. 292; "Owen's Lectures on Comp. Anat." vol. ii. pp. 78, 278; "Gray's Brit. Mus. Cat. of Amphibia," P. ii. p. 61.

IV. ORDER.—GANOID-FISHES (Ganoidei).

Endo-skeleton in some osseous, in some cartilaginous, in some partly osseous and partly cartilaginous; exo-skeleton ganoid; fins with the first ray usually a strong spine; a swimming-bladder; 1 air-duct.

1. *SUB-ORDER.*—CARTILAGINOUS GANOID-FISHES (Chondrostei).

Skeleton partly cartilaginous; vertebral column contains a soft *chorda* instead of vertebral bodies.

1. FAMILY.—*Sturgeons* (Acipenseridæ). Body covered with large indurated plates or tubercles; mouth beneath, cirrhated; bony jaws perform office of teeth.
2. FAMILY.—*Spoonbill-Sturgeons* (Polyodontidæ). Body without any tubercles or bony plates; muzzle excessively prolonged into a flat lanceolate plate; opercula absent.

2. *SUB-ORDER.*—OSSEOUS GANOID-FISHES (Holostei).

Vertebral column osseous.

3. FAMILY.—*Bichirs* (Polypteridæ). Body anguilliform, with hard scales; upper jaw not divided; dorsal fin sub-divided into a row of perfect, distinct finlets; gill-membrane cleft; no opercular-gill, or pseudo-branchia; a blowing-hole on each side with an osseous valve; pectorals pedunculated; swimming-bladder double.
4. FAMILY.—*Diamond-Fishes*[*] (Lepisosteidæ). Head and body mailed with thick plates and scales of stony hardness; upper jaw composed of several pieces; gill-membrane undivided, 3-rayed; a respiratory opercular-gill and pseudo-branchia; no blowing-hole; anterior margin of fins covered with two rows of

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[*] Called also "Bony-Pikes."

spinous scales; caudal fin truncate or bilobed swimming-bladder cellular.

5. **Family.** —*Amias* (Amiidæ). Form elongate head rounded; hard buckler on lower jaw, conical teeth on edges of jaw, and pavement-like ones behind; scales soft, without enamel, flexible, and rounded; no opercular accessory gills; no *fulcra* on fin-margins; swimming-bladder cellular.

V. ORDER.—Tufted-Gill Fishes (Lophobranchii).

Endo-skeleton partially ossified; exo-skeleton ganoid; gills tufted; opercular aperture small; swimming-bladder without air-duct.

1. **Family.** —*Pipe-Fishes* (Syngnathidæ). Body prolonged, slender, linear, or angulated; snout greatly prolonged, cylindrical; mouth terminal, vertical; ventral fins absent; caudal fin wanting in some.
2. **Family.**—*Sea-Horses* (Hippocampidæ). Head and body compressed; snout narrow, tubular; mouth terminal; pectorals small; dorsal single; caudal fin wanting.
3. **Family.**—*Winged Sea-Horses* (Pegasidæ). Body broad, depressed; snout suddenly contracted, narrow, somewhat protractile; mouth terminal, beneath; pectorals generally large; caudal fin small.

VI. ORDER.—Soldered-Jaw Fishes (Plectognathi).

Endo-skeleton partially ossified; exo-skeleton as ganoid scales or spines; maxillaries and pre-maxillaries fixed together; swimming-bladder without air-duct.

1. Family.—*Sun-Fishes* (Cephalidæ). Body oval or orbicular, compressed, spineless, not capable of inflation; jaws undivided; dorsal, caudal, and anal fins united.
2. Family.—*Globe-Fishes* (Gymnodontidæ). Body oval, scabrous or defended by prickles or by spines; belly capable of being greatly inflated; teeth none; jaws in some divided, giving the appearance of teeth.
3. Family.—*Trunk-Fishes* (Ostraciontidæ). Body smooth, triangular, or quadrangular, covered by angulated bony plates, soldered at sutures; dorsal single; ventral none.
4. Family.—*File-Fishes* (Balistidæ). Body compressed; skin coriaceous, granulated; muzzle prolonged; mouth very small; a few sharp teeth in each jaw; dorsals 2, ventral single.

VII. ORDER.—Spiny-Fishes (Acanthopteri).

Endo-skeleton ossified; exo-skeleton as ctenoid scales; fins with one or more of first rays unjointed, or inflexible spines; ventrals in most beneath, or in advance of the pectorals; swimming-bladder without air-duct.

1. Family.—*Fishing-Frogs* (Lophiidæ). Head very large, much flattened, often spiny or tuberculated; body depressed; tail small, compressed; skin naked; mouth often very wide, cleft horizontally; pectorals pedunculated.

2. FAMILY.—*Hand-Fishes* (Chironectidæ). Body naked, thick, generally compressed, sometimes tuberculated, no scales; mouth cleft vertically, lower jaw longest; pectorals pedunculated, capable of being used as feet.
3. FAMILY.—*Blenny-Bullheads* (Batrachidæ). Head broader than body, obtuse, depressed, with slender cirrhi; no distinct spines or bony tubercles; scales small, regular, sometimes embedded in skin and not visible externally pectorals broad, not pedunculated; mouth wide, not vertical; ventrals very small.
4. FAMILY.—*Blennies* (Blenniidæ). Body compressed; ventrals before pectorals, very slender, of two or three cylindrical rays; head thick, obtuse; lips fleshy; body covered with a slimy mucus; dorsal fins composed of spinous and soft rays.
5. FAMILY.—*Gobies* (Gobiidæ). Body elongated, slimy; head large, depressed; dorsal fins two, rays thin, setaceous, and flexible; ventrals united into a funnel; eyes approximating.
6. FAMILY.—*Dragonets* (Callionymidæ). Head and body depressed; first dorsal rays in some much elevated; ventrals larger than pectorals, distinct, shortest rays, in some, in front; in some, wanting.
7. FAMILY.—*Suckers* (Cyclopteridæ). Body ovoid or oblong, slimy, scales none; pectorals very broad, and uniting with a transverse mem-

brane connecting the ventrals, forming an oval, concave disk; branchial spiracle one; eyes on each side, approximating.

8. FAMILY.—*Sucking-Fishes* (Echeneidæ). Body lengthened, sub-anguilliform, covered with small scales; crown flat, bearing a flattened disk, composed of moveable, transverse, cartilaginous laminæ, placed obliquely backwards; mouth cleft horizontally.

9. FAMILY.—*Slender-rayed Blennies* (Chiridæ). Body compressed; dorsal rays slender; ventrals distinct; several lateral rows of pores along side of body; mouth slightly cleft.

10. FAMILY.—*Wolf-Fishes* (Anarrhichadidæ). Body elongate, slightly compressed; dorsal, caudal, and anal fins united; rays soft.

11. FAMILY.—*Flute-Mouths* (Fistulariidæ). Body long, slender, linear; scales none; long tubular projection in front of cranium formed by an extension of anterior cranial and facial bones; mouth terminal, vertical.

12. FAMILY.—*Sea-Snipes* (Centriscidæ). Body oval or oblong, unelongated, compressed; snout tubular, prolonged; first dorsal spines long; body covered with scales, or mailed with broad scaly pieces.

13. FAMILY.—*Lancet-Fishes* (Acanthuridæ). Body compressed, ovate or oblong; tail armed with lateral spines; dorsal single; mouth small, slightly or not at all protractile. (*Theutyes*, Cuv.)

14. Family.—*Riband-Fishes* (Gymnetridæ). Body very long, thin, and compressed; head large, generally truncate; eyes very large; mouth nearly vertical; consistence soft; rays fragile.

15. Family.—*Star-scaled Dolphins* (Astrodermidæ). Crown gibbous, obtuse; mouth and eyes very small; ventrals on the throat, nearly obsolete, first ray serrated; body with scattered, detached, star-like scales.

16. Family.—*Scabbard-Fishes* (Trichiuridæ). Ventrals rudimentary or wanting; finlets none; body narrow, linear; jaws lengthened, the under the longest; chin pointed; teeth generally large, remote, unequal, and acute.

17. Family.—*Pomfrets* (Stromateidæ). Body very thin, short, rhomboid; back with minute prickles; head obtuse; ventrals generally none; scales minute; apparently two lateral lines.

18. Family.—*Fish-Dolphins* (Coryphænidæ). Body compressed, oblong, slender; scales small, numerous; head large; crown gibbous; pectorals falcate; eyes close to angle of mouth.

19. Family.—*Dories* (Zeidæ). Body stout, oval, or rhomboid, very broad in middle, and excessively thin; mouth small compared with size of head, often protractile; dorsal generally single; caudal sometimes forked; scales minute or none.

20. Family. — *Spiny-Mackarels* (Centronotidæ). Body lengthened or oblong; spines in front of dorsal; dorsals two, not connected; ventrals perfect; scales generally very small.

21. FAMILY.—*Spine-Backs* (Notocanthidæ). Body anguilliform, much compressed; dorsal and anal, when present, very long, and close to caudal which is small; series of free, detached spines before dorsal; snout produced.

22. FAMILY.—*Scale-less Mackarels* (Alepisauridæ). Body lengthened, linear, much compressed; head lengthened, pointed; teeth large, unequal, very acute; mouth wide; two dorsals, the hinder adipose; scales none.

23. FAMILY.—*Sword-Fishes* (Xiphiidæ). Upper jaw excessively prolonged, considerably flattened above, the edges sharp; mouth beneath; ventrals either wanting, or a single inflexible bone in each.

24. FAMILY.—*Mackarels* (Scomberidæ). Body oblong, lengthened, smooth, covered with very small scales; caudal fin deeply forked, large; tail often bearing spurious finlets; no fleshy lips; dorsals two, in some close together.

25. FAMILY.—*Climbing-Fishes* (Anabatidæ). Body ovate, sub-fusiform, or cylindrical; dorsal fin single, mostly with spinous rays; upper pharyngeals of branchia divided into numerous small, irregular lamellæ, forming small cells, in which they have the power of retaining water, for moistening the gills when the animal is on shore; dorsal single; ventral generally extremely long, narrow, and ending in a filament.

The members of this family are remarkable for the property they possess of being able to crawl out of the water, being enabled to respire by means of the water contained in the labyrinthic cells connected with the gills. Some species are exhibited for this purpose by Indian jugglers. (*Labyrinthici*, Cuv.)

26. FAMILY.—*Stickle-Backs* (Gasterosteidæ). Body oblong, or linear; back armed with a row of small spines, or prickles; snout often prolonged into a tube.

27. FAMILY.—*Sea-Pikes* (Sphyrænidæ). Body linear; jaws produced, broader than high; teeth strong, those in front much lengthened; dorsals two, triangular, remote; ventral under first dorsal.

28. FAMILY.—*Gray-Mullets* (Mugilidæ). Body oblong, sub-cylindrical; scales large; snout short, obtuse, generally projecting beyond mouth; dorsals two, remote, the first of strong spiny rays; teeth very small; eyes large, close to snout; caudal fin forked, or lunated.

29. FAMILY.—*Sea-Breams* (Sparidæ). Fins naked; pectorals pointed; caudal fin forked; no spines on operculum; pre-operculum smooth; snout not gibbous; teeth strong, none on palatines.

30. FAMILY.—*Maigres* (Sciænidæ). Fins generally scaled at base; operculum armed with spines; pre-operculum serrated; teeth strong; none on vomer or palatines; bones of cranium and

face generally cavernous; snout more or less obtuse; dorsals two or one.

31. FAMILY.—*Chætodons* (Chætodontidæ). Body short, broad, much compressed; dorsal, caudal, and anal fins thickly covered with minute scales; mouth very small; teeth setaceous, long; dorsal fin generally single.

32. FAMILY.—*Mendoles* (Mœnidæ). Body oblong or fusiform; upper jaw extremely extensible; teeth small, fine, crowded; covered with scales; caudal generally forked or lunate.

33. FAMILY.—*Riband-Gurnards* (Lepidosomatidæ). Body anguilliform, sword-shaped, very thin, covered with osseous scales, rough, and beset with small acute spines; head depressed, mailed; dorsals two, the first small, the second long, and united with anal and caudal; ventrals small.

34. FAMILY. — *Gurnards* (Triglidæ). Head covered with bony plates resembling armour, and defended with large spinous processes; scales rough, cuspidate, or prickly; caudal fin generally lunate; distinct finger-like processes generally placed at base of pectorals; pectorals often very large.

35. FAMILY.—*Sea-Scorpions* (Scorpænidæ). Head compressed; mouth opens horizontally; body generally covered with smooth scales; eyes prominent, lateral; pectorals with some of lower rays detached, but without digitated processes.

36. **Family.**—*Hog-Fishes* (Synanchiidæ). Body naked, without scales, thick, gross, often deformed with fungus, or spongy skin, with fleshy lobes, or cirrhi on sides; head spinous, directed upwards; eyes small, close to or upon crown; mouth large, vertical; pectorals large, often very long.

37. **Family.**—*Weevers* (Trachinidæ). Body ovate or elongate; head compressed or cuboid; mouth and eyes mostly vertical; body covered with compact scales; ventral before pectorals, very small in some.

38. **Family.**—*Flat-Heads* (Platycephalidæ). Head and body broad, and depressed; eyes large, vertical; ventrals large; dorsals two; body scaly; no tubercles or filaments on head.

39. **Family.**—*Mailed-Bullheads* (Agonidæ). Body angulated, generally long and slender, covered with mailed plates; jaws prolonged, somewhat tubular; no teeth on vomer; ventrals of two rays, very small.

40. **Family.**—*Bullheads* (Cottidæ). Head large, broad, depressed, armed with spines and tubercles; mouth large; small teeth on jaws and vomer, none on palate; body naked, or with patches only of minute scales; dorsals generally two, either separate, or united at base; ventrals small, imperfect, behind pectorals.

41. **Family.**—*Surmullets* (Mullidæ). Body obovate, anterior part thicker than posterior; head

large, high; profile abrupt, sub-vertical; eyes lateral, close to crown; mouth and teeth very small; ventral profile of fish nearly straight; opercula denticulated; covered along the body with large deciduous scales; dorsals two, remote; caudal fin forked; two fleshy cirrhi beneath lower jaw.

42. FAMILY. — *Naked-headed Perches* (Helotidæ). Head and muzzle naked; dorsal fin one, deeply emarginate; dorsal, and often anal fins sheathed at base with scales; pectorals pointed; spines on middle of operculum; jaw-teeth numerous, small, close-set.

43. FAMILY.—*Spiny-headed Perches* (Holocentridæ). Body covered with hard, rough, or denticulated scales, or mailed plates; head very spiny; mouth often oblique; dorsal emarginate.

44. FAMILY.—*Serpentiform-Perches* (Percophidæ). Body ovate, or lengthened; ventrals before pectorals; dorsals entire, mostly single; spinal rays weaker, and shorter than the others.

45. FAMILY.—*Sea-Perches* (Serranidæ). Body oblong; dorsal fin single, emarginate; branchial membrane mostly with seven rays; jaws with strong canines.

46. FAMILY. — *Perches* (Percidæ). Body oblong; scales distinct, generally hard or rough; teeth in jaws, on vomer and palate; operculum spined; pre-operculum serrated; dorsal fins two, distinct; no canines.

VIII. ORDER.—SPINE-LESS FISHES (Anacanthini).

Endo-skeleton ossified; exo-skeleton in some as cycloid, in others as ctenoid scales; fins supported by flexible or jointed rays; ventrals beneath pectorals, or none; swimming-bladder without air-duct.

I. *SUB-ORDER.*—THORACIC SPINE-LESS FISHES (Thoracici).

1. FAMILY.—*Flat-Fishes* (Pleuronectidæ). Body oval, very thin; dorsal and ventral fins extend nearly whole length of fish; head non-symmetrical; both eyes on same side of head; swim on the side; seldom quit the bottom.
2. FAMILY.—*Anguilliform Cod-Fishes* (Brotulidæ). Body anguilliform; scales very small; dorsal fin one, united to caudal and anal, terminating in a point.
3. FAMILY.—*Torsks* (Brosmiidæ). Body elongated; dorsal fin one, long, extending whole length of body; ventrals fleshy.
4. FAMILY.—*Forked-Beards* (Phycidæ). Head broad, depressed; dorsal fins two; ventral fins with posterior rays obsolete, or altogether wanting, the anterior rays being prolonged and forked; chin furnished with a cirrhus.
5. FAMILY.—*Hakes* (Merlucciidæ). Body elongate; dorsals fins two, the first sometimes composed of fleshy filaments, and scarcely perceptible; anal fin one; ventrals with five distinct rays.
6. FAMILY.—*Cod-Fishes* (Gadidæ). Body slimy; scales very small; fins fleshy; all the rays

soft, and covered with the common skin; head large, depressed; body more or less lengthened, compressed; dorsal fins three; anal two; ventrals very small.

II. *SUB-ORDER.*—Apodal Spine-less Fishes (Apodes).

7. **Family.**—*Donzelles* (Ophidiidæ). Body anguilliform, compressed, fins more or less fleshy; ventrals obsolete; dorsal, caudal and anal fins united; body invested with small scales in the thickness of the skin.

IX. ORDER.—Pharyngeal Fishes (Pharyngognathi).

Endo-skeleton ossified; exo-skeleton in some as cycloid, in others as ctenoid scales; inferior pharyngeal bones coalesced; swimming-bladder without duct.

I. *SUB-ORDER.*—Spiny Pharyngeal-Fishes (Acanthopterygii).

1. **Family.**—*Ctenoid-Wrasses* (Cteno-Labridæ). Body oval; pre-operculum mostly dentated; lateral line interrupted; colours diversified; scales ctenoid.
2. **Family.**—*Cycloid-Wrasses* (Cyclo-Labridæ). Body oval or fusiform, scaly; colours brilliant; lips thick, fleshy; cutting teeth sharp, simple, distinct; those in front longest; operculum smooth; pre-operculum sometimes serrated; lateral line abruptly bent, or totally interrupted at end of dorsal fin; scales cycloid.
3. **Family.**—*Parrot-Fishes* (Scaridæ). Head and

crown elevated; jaws convex, rounded, with teeth arranged like scales on their edge and anterior surface; scales at base of caudal very large.

4. FAMILY.—*Coracines* (Chromididæ). Body oval or elongate; teeth setaceous, often minute, and very fine; operculum scaled; pre-operculum smooth; ventrals very long.

II. *SUB-ORDER.*—SOFT-FINNED PHARYNGEAL-FISHES (Malacopterygii).

5. FAMILY.—*Saury-Pikes* (Scomberesocidæ). Body herring-shaped or elongate; mouth obliquely cleft; teeth small, acute; eyes large.

X. ORDER.—SOFT-FINNED FISHES (Malacopteri).

Endo-skeleton ossified; exo-skeleton in most as cycloid, in a few as ganoid scales; fins supported by rays, all, save the first sometimes in the dorsal and pectoral, soft or jointed; abdominal or apodal; gills free; operculate; a swimming-bladder and air duct.

I. *SUB-ORDER.*—ABDOMINAL SOFT-FINNED FISHES (Abdominales).

1. FAMILY.—*Mailed Sheat-Fishes* (Loricariidæ). Body lengthened; head and body mailed with large osseous plates; head depressed; eyes small; mouth beneath. (*Goniodontes*, Ag.)

2. FAMILY.—*Naked Sheat-Fishes* (Pimelodidæ). Body compressed, more or less naked; dorsal fins two, the hinder adipose; muzzle not produced; anal fin short.

3. FAMILY.—*True Sheat-Fishes* (Siluridæ). Body slightly elongate, compressed, generally slimy; anal fin and tail long; operculum moveable; mouth furnished with cirrhi.

The genus *Malapterurus* possesses electric properties, but in a less degree than the *Gymnotus* or *Torpedo.*

4. FAMILY.—*Flat-Headed Sheat-Fishes* (Aspredinidæ). Eyes very small, vertical; operculum immoveable, the aperture opening only by a a narrow slit beneath the head; under jaw transverse, and shorter than the upper; first pectoral ray generally excessively developed; dorsal single, close to head.

5. FAMILY.—*Long-Headed Sheat-Fishes* (Pteronotidæ). Head large, much lengthened, depressed, bony; muzzle broad and obtuse, projecting beyond the lower jaw; cirrhi long; dorsal fins two, the hinder generally adipose; caudal lobed or forked, rarely lunate.

6. FAMILY.—*Double-Eyed Loaches* (Anablepidæ) Body cylindrical, covered with stout scales; head small, short, depressed, not widened; eyes very prominent, *apparently* double; mouth transverse; generation viviparous.

7. FAMILY. — *Loaches-proper* (Cobitidæ). Body lengthened, slimy; head with cirrhi; mouth inferior; teeth none; gill-opening small; dorsal fin central, above the ventral.

8. FAMILY. — *Thick-bodied Loaches* (Pœciliidæ). Body thick, oval, compressed; scales large;

head small, flattened above; snout sharp; mouth small, transverse; jaws protractile; generation viviparous. (*Cyprinodontes*, Ag.)

9. FAMILY.—*Carps* (Cyprinidæ). Body compressed, covered withs cales, which are generally large; fins naked; mouth small; jaws weak, without teeth; strong teeth on pharynx; tongue smooth; dorsal single, generally in centre of back.
10. FAMILY.—*Small-mouthed Pikes* (Mormyridæ). Body compressed, oblong, scaly; muzzle produced; mouth terminal, vertical; teeth small, slender; branchial aperture resembling a spiracle.
11. FAMILY.—*Pikes* (Esocidæ). Body compressed, scaly; dorsal fin single, close to end of tail; mouth large; teeth numerous, acute; very voracious.
12. FAMILY.—*Galaxies* (Galaxiatidæ). Scales obsolete; mouth small, slightly cleft; pointed teeth on palatines and jaws, strong hooked teeth on tongue; dorsal, and anal fins opposite.
13. FAMILY.—*Deep-bodied Salmons* (Myletidæ). Depth of body as much, or more than half the length; head small; snout blunt; upper jaw small, strongly angulated in some; sharp, triangular cutting teeth on lower jaw larger than those of upper; belly in some sharp and serrated.
14. FAMILY.—*Wide-mouthed Salmons* (Scopelidæ). Snout short; mouth deeply cleft; teeth

rather small, sharp; branchial rays eight to fifteen; first dorsal behind ventral; body in some semi-transparent.

15. FAMILY.—*True-Salmons* (Salmonidæ). Body covered with compact scales; jaws generally well furnished with teeth; dorsal fins two, first with soft rays, the second small and adipose; mostly voracious.

16. FAMILY.—*Herrings* (Clupeidæ). Body compressed, always covered with numerous scales; mouth mostly moderate; lips thin; teeth minute or none; gill-aperture large; dorsal fin single.

17. FAMILY.—*Blind-Fishes* (Amblyopsidæ). Form elongate; head obtuse, rounded, without scales; scales on body very small, oval, entire, concentrically striated; eyes as minute black points covered by the skin, or none, cornea none; gills four; pseudo-branchiæ none; *anus* in front of pectoral fins between posterior inferior terminations of opercula. Viviparous. (*Heteropygii*, Tellkampf.)

II. *SUB-ORDER.*—APODAL SOFT-FINNED FISHES (Apodes).

18. FAMILY.—*Electric-Eels* (Gymnotidæ). Body linear, anguilliform, but compressed, often with small scales; ventrals none.

In this family the most noted species is the Electric Eel *(Gymnotus electricus)* of South America, The electric apparatus is placed along the under side of the body, extending from behind the pectorals to the tail. The organs are four in number, two on either side, and one above the other, the upper ones being the larger. The organs of one side are separated from those of the other by the vertebral column, its muscles, the air-bladder, and an aponeurotic septum, from which last, and from one covering the air-bladder, extend outwards to the skin numerous horizontal membranes, arranged in the longitudinal axis of the body. These are intersected transversely by more delicate vertical plates, which thus form cells, filled with a pellucid liquid. The battery is thus horizontal; and it has been shewn by Faraday, that the electric current is always from the anterior to the posterior parts of the animal. In this fish the electric organs are supplied by the ventral branches of all the spinal nerves.*

19. FAMILY.—*Eels* (Murænidæ). Body serpentiform; scales very small, enveloped in a mucous epidermis; branchial spiracles two, lateral, placed one on each side; ventral fins wanting.

20. FAMILY.—*Sub-branchial Eels* (Synbranchidæ). Body anguilliform; spiracles two, or in some one, placed under the throat. (*Symbranchii*, Müll.)

XI. ORDER.—SUCTORIAL-FISHES (Dermopteri).

Endo-skeleton unossified; exo-skeleton, and vertical fins muco-dermoid; vermiform, or abrachial, and apodal; no pancreas; no air-bladder.

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* *See* Owen's "Lectures on Comparative Anatomy," vol. ii., p. 218.

I. *SUB-ORDER.*—ROUND-MOUTHED SUCTORIAL-FISHES (Marsipobranchii, seu Cyclostomi).

Gills fixed, bursiform, inoperculate, receiving respiratory streams by apertures usually numerous and lateral, distinct from the mouth ; a heart.

1. FAMILY.—*Lampreys* (Petromyzontidæ). Body elongated ; eyes small or none ; mouth circular ; teeth distinct ; branchial openings mostly seven ; nasal aperture closed ; palate entirely covered with skin.
2. FAMILY.—*Glutinous-Hags* (Myxinidæ). Body cylindrical ; eyes none ; branchial apertures two ; a single tooth on upper part of maxillary ring ; palate perforated.

II. *SUB-ORDER.*—FRINGED-MOUTHED SUCTORIAL-FISHES (Pharyngobranchii, seu Cirrhostomi).

Gills free, pharyngeal, inoperculate ; no heart.

3. FAMILY.—*Lancelets* (Amphioxidæ). Body compressed, hyaline ; mouth narrow, elongated, the margins furnished with slender filaments.

MOLLUSKS.

The unsymmetrical, soft, and fleshy bodies of the animals forming the Sub-Kingdom of the Mollusks have no internal bony skeleton to protect the nervous centres, nor are they covered with a horny, jointed skin like the tribes of *Annulosa.* Nature, however, not to leave them altogether destitute in this respect, has invested them with a muscular tunic or mantle, which often secretes a shelly coat to guard the more delicate organs from external violence. These shelly envelopes are the prized, and much sought for, objects of the Conchologist, and are alike remarkable for their imperishable nature, the extreme beauty and elegance of their forms, the richness of their colouring, and the delicacy and endless diversity of their sculpture and markings. The molluscous architects of these calcareous homes are generally apathetic beings, displaying but a small amount of energy when contrasted with the restless, active, air-breathing legions of the articulated classes.

They comprise the *Cephalopods*, the highest of their class, with prehensible arms disposed around their mouth, large and perfect eyes, and with the sexes separate; the *Pteropods*, with their bodies often enclosed in fragile shells of glassy transparency, and with fin-like expansions on the sides of their heads to enable them to navigate the high seas; the *Gasteropods*, furnished with a muscular disk on the lower portion of their bodies adapting them for crawling on the ground, and with distinct head, eyes, and tentacles; the *Bivalves*, protected by solid shelly plates, headless, and breathing by means of plait-like gills; the soft, aquatic, headless *Tunicaries*, either free and isolated, or united organically in a common brotherhood; and the *Brachiopods*, enclosed in bivalve shells, breathing by the mantle, and with long spiral or twisted arms on the sides of the mouth, by the ciliary movements of which they create currents to bring them food. In arranging the classes of *Mollusca*, the characters are principally determined by the organs of locomotion; in the orders the nature of the branchial apparatus is taken advantage of; in the diagnosis of families the lingual dentition and peculiarities of configuration form the leading points; in genera, the form of the shell is chiefly considered; and in species, the colour and sculpture of the shelly envelope.

The molluscous tribes, with a few exceptions, reproduce by eggs which are deposited by the mother in situations best adapted to insure incubation, and in numerous instances, are protected by a leathery envelope or gelatinous nidus; the young fry, when first excluded from the egg, are enclosed in little shells fitted with a lid, and swim about by the aid of fins; as the animal grows older the fins disappear, and frequently the shell falls off, and gills and tentacles become developed. The senses of the *Mollusca* are not acute; they are mostly dumb, their vision is imperfect, their smell limited, their taste implied, their touch obtuse, and their energies are mainly directed to the procuring of food, and the multiplication of their species. The intensity of their instinct, and the power of their volition and motive power will, however, be found to vary in proportion to the complexity of their organization, being feebly expressed in the lowest or Annuloid forms, and more perfectly manifested as we approach the Vertebrate type, as shewn in the class of Cephalopods.

Like other animals, the *Mollusca* obey certain laws, and offer peculiarities in their geographical distribution. Thus, as we approach the equator from the poles, we find their size, beauty, and variety, gradually increase; the species are also more numerous near the shores, but perceptibly diminish as the water deepens; and, in like manner, the land shells are large and abundant in the valleys, and become smaller and less in number as we ascend the mountains. Rivers, lakes, ponds, and springs are peopled by numerous tribes, as the *Ampullariæ* of South America; the *Melaniæ* of the East Indies; and the *Limnæi* of Europe. The pelagian forms are found in all oceans, as the *Ianthina*, the *Carinaria*, and the Argonaut.

In the Northern Seas the shells are of a dingy hue, and often covered with an epidermis, while in the tropics they often vie in splendour with the fishes, and are sometimes highly polished. The Mediterranean and the surrounding regions are very rich in *Mollusca*, the number of species of *Clausilia* being especially great; the deserts of Africa give sustenance to few species, but what are known are of a peculiar character; while the rivers also yield singular types, such as *Ætheria* and *Galathea;* in South Africa we observe the great *Achatinæ*, and the sinistral *Lanistes;* while the Cape of Good Hope is famous for its species of *Patella*. The shells of the Canary Islands and of the Madeiras, are nearly all of a peculiar stamp; and the West Indies harbour an abundance of forms, each island containing species peculiar to itself, Jamaica being particularly rich in *Cyclostomata*, *Helicinæ*, and *Cylindrellæ*. South America is the grand emporium of the *Bulimi* and *Chilinæ;* while the great rivers of North America are extremely prolific in *Unio* and *Anodonta;* and the West coast is remarkable for its numerous examples of *Chiton*, *Calyptra* and *Fissurella*. The islands of the Pacific Ocean also exhibit several peculiarities in their molluscous fauna; the *Struthiolaria* and *Amphibola* are from New Zealand; the *Trigonia*, *Chamostrea*, and *Myochama*, are from New Holland; the *Partula* is from the Society and Sandwich islands; while the *Orthostylus* and kindred forms people the wooded parts of the Philippines; and the *Nanina* is from Borneo and Java, which also furnish us with numerous *Auriculæ*. The great Island of Madagascar and the other islands in the Indian Ocean, also yield their peculiar species of mollusks, both terrestrial and marine.

II.—SUB-KINGDOM OF MOLLUSKS.—*Mollusca*.

Animal invertebrate, without jointed limbs; body soft, furnished with a mantle, which usually secretes a calcareous envelope or shell; heart bilocular; nervous system forming a transverse series of medullary masses, or ganglia arranged around the gullet.

CEPHALOPODS.

The Cephalopods, comprising the Cuttle-fishes, the Squids, the Argonauts, and the *Nautili*, are by far the most highly organized and intelligent of the Molluscous tribes. Their head is separate from the body, their eyes are large and complex, their ears are developed, and they even possess the rudiments of an endo-skeleton. They are varied in their habits and mode of life, but all agree in being carnivorous and raptorial, preying on *Crustacea* and other small animals, which they seize with their long and muscular arms, secure near their mouth by innumerable suckers, and tear in pieces with their horny mandibles. The *Octopi* frequent the shores, and when molested escape from the pursuit of their enemies by ejecting a coloured fluid from their ink-bag, which obscures the water around them; crabs and lobsters constitute their favourite food. The Argonauts are oceanic in their habits, frequenting the high seas, swimming rapidly backwards by ejecting the water through their funnel, while their upper expanded arms firmly embrace the sides of their shell, recent observation having effectually dispelled the poetic notion so long entertained of their sailing along the surface. Some, like the *Ommastrephes* or Flying Squids, have the power of leaping out of the water, so as sometimes to fall upon the decks of vessels; others, like the Pelagian Cuttles (*Philonexidæ*), inhabit the solitudes of the ocean, assembling together in large shoals, so as even sometimes to discolour the water, and preying in the night upon the small fishes and floating *Medusæ* that swarm in the upper regions of the ocean.

That somewhat apocryphal Cephalopodic monster, the "Kraken," concerning which the fishermen of the Scandinavian shores have many legends, will most probably be found to belong to the family of Cuttles.

During the early ages of the world's history, when vast tracts were covered by a surging ocean, the Cephalopods played an important part in the drama of animal existence, peopling the warm seas in prodigious numbers. Then might be seen gigantic Ammonites, with large and lustrous eyes, and long extended arms, shuffling awkwardly along the surface of the primeval rocks, or engaged in deadly struggles with strange-formed antediluvian fishes; then solitary *Octopi*, of colossal size, equally carnivorous and fierce, might be seen prowling among the sunken reefs, with eager heads directed downwards, seeking whom they might devour. At that epoch Belemnites, with long slender bodies and small lateral fins, were darting vertically up and down the watery abyss; while thousands of pearly *Nautili*, taking the place of the predaceous Gasteropods that now keep in check the excessive increase of the smaller marine animals, might have been detected crushing with their calcareous mandibles the plaited bodies of the old-world Trilobites.

I. CLASS.—CEPHALOPODS (*Cephalopoda*).

Body ovate; mantle open in front; gills one or two pairs; head large, separate from the body; mouth with horny or shelly jaws, surrounded by eight or ten fleshy arms; a tube or siphuncle used in locomotion; sexes separate; shell internal or external.

I. ORDER.—OCTOPODS (Octopoda).

Body roundish; head with eight fleshy arms furnished with sessile cups or suckers; eyes fixed; gills two; shell none or rudimentary.

1. FAMILY.—*Octopods* (Octopodidæ). Arms similar, elongated, united at the base by a web, mantle supported by fleshy bands; cephalic aquiferous-apertures none; shell represented by two short styles in the substance of the mantle. Littoral.
2. FAMILY. — *Pelagian - Octopods* (Philonexidæ). Arms subulate; cups peduncled, in two rows; eyes large and prominent; mantle supported by two buttons at base of siphuncle fitting into grooves of mantle; shell none. Pelagian.
3. FAMILY.—*Argonauts* (Argonautidæ). Arms subulate, the two upper dilated, secreting (in the female) a symmetrical involute shell; mantle supported by two buttons fitting into grooves at base of siphuncle; shell external, one-celled, thin; apex involute.

II. ORDER.—DECAPODS (Decapoda).

Body naked, more or less elongated; head with ten fleshy arms, the two longer or (tentacular) arms with peduncled cups with horny rings; eyes free in orbit; gills two; shell internal, medial.

I. *SUB-ORDER.*—CHONDROPHORES (Chondrophora).

Shell solid, horny or cartilaginous, more or less lanceolate, with a produced and thickened apex.

1. FAMILY.—*Cranchias* (Cranchiidæ). Body large and membranous; head small; eyes large and prominent, covered with a skin; mantle supported by two internal fleshy bands; siphuncle with a valve; club of tentacular arms finned; fins of body small and terminal.
2. FAMILY. —*False-Squids* (Loligopsidæ). Body elongate, membranous, tapering behind; eyes peduncled, not covered by a skin; mantle supported by two internal fleshy bands; siphuncle simple; fins caudal, terminal, semicircular.
3. FAMILY. —*Long-armed Calamaries* (Chirateuthidæ). Body elongate, tapering; ears without crest; eyes naked, simple, above; mantle with three internal cartilages, one dorsal and two ventral; siphuncle simple, without a valve; tentacular arms outside the web, not retractile; fins on hind part of back.
4. FAMILY.—*Hook-armed Calamaries* (Onychoteuthidæ). Head moderate, cylindrical; eyes naked with a sinus at upper part; ears with a longitudinal crest; mantle with three internal cartilages, one dorsal and two ventral; tentacular arms with a group of small sessile cups at end of club; fins posterior, dorsal, angular.

5. **Family.**—*Squids* (Loliginidæ). Eyes simple, covered with skin; ears with a transverse crest; buccal membrane often with cups; mantle with three internal cartilages, one dorsal two ventral; tentacular arms partially retractile; fins on sides of hind part of back.

II. *SUB-ORDER.*—**Sepiophores** (Sepiophora).

Shell cellular, calcareous, back hard; cavity filled with laminæ, separated by numerous cells.

6. **Family.** — *Cuttles* (Sepiidæ). Head united to mantle by a broad cervical band; eyes covered with the skin; mantle with two cartilaginous ridges on ventral side; tentacular arms, expanded at the end, entirely retractile; buccal membrane without cups; siphuncle with an internal valve.

III. *SUB-ORDER.*—**Belemnophores** (Belemnophora).

Shell calcareous, internal, chambered; chamber traversed by a siphon.

7. **Family.**—*Spirulas* (Spirulidæ). Eyes covered with the skin, lower eye-lid distinct; mantle free all round, a linear cartilage on inner side of ventral surface; body sub-cylindrical, rounded at the end; buccal membrane without cups; sessile arms triangular, with six rows of small peduncled cups—tentacular arms elongate, cylindrical, club—? siphuncle with an apical valve; shell internal, shelly, spiral, chambered; chambers with a siphon. Pelagic.

III. ORDER.—Polypods (Polypoda).

Body without fins; head not separate from the body; with a great number of cylindrical, retractile, annulated arms, without cups; gills four.

1. Family.—*Nautili* (Nautilidæ). Siphuncle slit; a distinct foot-like appendage; body enclosed in the last chamber of a shell; shell involute, discoidal, few-whorled; septa dividing the chambers simple; inner surface pearly.

PTEROPODS.

The Pteropods rank among those little-known beings that serve to people the expanse of the great oceans, occurring both in northern latitudes and in intertropical regions in vast multitudes. Being nocturnal or crepuscular in their habits, they are not generally observed; at the setting of the sun, however, they come from various depths towards the surface, and may then be readily taken in a towing-net. They swim rapidly, though in an irregular manner, progressing by sudden jerks, and move in every direction by means of their large lateral wing-like fins. The different species make their appearance near the surface at certain fixed times, and seem to dwell in the water at a depth peculiar to themselves; some come to the surface at the setting of the sun, but many of the larger ones do not ascend till towards midnight. Those genera that have their bodies protected by a shell are most numerous in species; their shells are varied in form, and are glassy, clear, and transparent; they are beautiful objects, but on account of their fragile nature and their inaccessible oceanic habitats, are not often found in the Collections of Conchologists, or even in those of National Museums.

Many peculiar forms of Pteropods seem to swarm in the polar seas; and one genus, the *Limacina*, occurs in such prodigious multitudes as even to constitute the principal food of the mighty Baleen-Whale. The long pallial prolongations often protruded from the fissures in the sides of the shells, do not appear to be of much service in propelling or guiding these animals through the water, but are most probably subservient to respiration.

II. CLASS.—PTEROPODS (Pteropoda).

Head more or less distinct; eyes none; mouth often furnished with cup-like appendages; fins two, usually on sides of mouth, often with an intermediate lobe; body ovate or roundish; unisexual? free, floating on the surface of the sea by means of their fins; crepuscular or nocturnal.

I. ORDER.—SHELL-BEARING PTEROPODS (Thecosomata).

Head indistinct, with two wings on sides of mouth; tooth of lingual membrane hooked, with a strong hooked tooth on each side; gills internal; body enclosed in a shell.

1. FAMILY.—*Spiny-Pteropods* (Cavolinidæ). Fins united, no foot-like appendage between them;

gills in pairs; abdomen voluminous; shell symmetrical, calcareous, globular or elongate-conical, furnished with spiny processes.

2. **Family.**—*Subulate-Pteropods* (Tripteridæ). Body elongate, cylindrical, fore part with two large lateral wings united below to a flat central portion; shell sub-cylindrical, calcareous, sub-angular near the mouth, ending in an acute point separated from the anterior cavity by a transverse septum; tip often deciduous in the adult.

3. **Family.**—*Slipper-shaped Pteropods* (Cymbuliidæ). Animal globular or ovate; fins two, on each side of mouth, with a small intermediate lobe; shell cartilaginous, slipper-shaped, rarely wanting.

4. **Family.**—*Spiral-Pteropods* (Limacinidæ). Body spiral, fins elongate, rounded, united at their base by an intermediate lobe bearing an operculum; mantle large, open in front; shell spiral, usually sinistral, and produced on the collumellar side; operculum distinct, spiral vitreous.

II. ORDER.—NAKED-PTEROPODS (Gymnosomata).

Body naked, without any shell; head distinct; fins two or four, at junction of head and body, a central intermediate lobe; gills exterior; shell none.

1. **Family.**—*Clios* (Clionidæ). Body fusiform; head with a series of conical prominences on each side; wings two, with an intermediate foot-like appendage.

2. FAMILY. — *Pneumoderms* (Pneumodermonidæ). Body fusiform; head with arms furnished with pedicellate suckers; wings two, with a central foot-like appendage; gills on hind part of body.
3. FAMILY. — *Cymodoceas* (Cymodoceidæ). Body divided into two parts; wings four, two on each side, at the junction between head and abdomen, with a foot-like appendage.

GASTEROPODS.

The Gasteropods, comprising the tribes of the spiral shell-bearing Mollusks, will be eagerly sought after by the enterprising traveller on account of their rarity and beauty, nor will he have to look in vain for traces of their whereabouts.

On the bosom of the ocean fleets of purple *Ianthinæ* and sprightly Atalants, with clear transparent shells, and sometimes a Glassy-Nautilus (*Carinaria*), swift and rapid in its movements, will be noticed on his outward voyage; nor will the pelagian Dorids and Eolids that occupy the stems of floating sea-weeds escape his observation.

Wandering amid the labyrinths of tropical forests, he will discover, sheltered by the leaves, or hid among the fissures of the bark, showy-looking *Bulimi*, and fine banded Snails, while active *Naninæ*, with their truncate, glandular tails, will be seen among the foliage of the lower bushes, or hiding in the moss and dead leaves at the foot of the trees; and among their tangled roots he will bring to light earth-loving Cyclostomes and ear-shaped Land-Volutes. The beds of ancient torrents, decaying rocks, and the debris of mountain slopes, will also yield him curious flattened, dingy *Helicidæ*, and the slug-like forms of *Onchidium* and *Veronicella*.

If he is near the coast, he will find, on the rocks, the Chitons, with their coats of mail, the curious Cup-and-Saucer Limpets, and the beautiful pearly Ear-shells; and among the coral reefs the polished Cowry, or the spine-armed *Murex;* nor will the numerous kind of Wreath and Top-shells be overlooked in his search among the stones along the strand. Here also, perchance, he may discover some of the elegant Volutes, frequently as rare and costly as they are beautiful; and he may notice the large and powerful animals of the *Strombidæ*, or Wing-Shells, with their telescope-eyes and strong muscular foot, leaping and rolling about in pursuit of prey; Purple-Shells and Periwinkles will be observed grazing on their sea-weed pastures, in company with gaudy-coloured Nerites; while on the sand-flats he will see the Naticas and the glossy Olives, partially covered by expansions of their foot, forming burrows in the moist soft bed on which they pass their lives; here also will be seen the large-footed *Bullia* and the Nassas, with their bifid turned-up tails, describing sinuous tracks as they quickly traverse the surface of the yielding sand; while in the coral-masses around him a careful search will enable him to discover, securely lodged, the curious *Magilus* and the *Leptoconchus*.

III. CLASS.—GASTEROPODS (Gasteropoda).

Head distinct, furnished with eyes and tentacles; body usually protected by a spiral or conical shell; adult walking on an expanded foot.

I. *SUB-CLASS.*—PROSOBRANCHS (Prosobranchiata).

Heart placed behind gills; sexes distinct; gills comb-like, on back of mantle or round its edge.

I. ORDER.—PECTINIBRANCHS (Pectinibranchiata).

Gills formed of one or two series of laminæ on left side of mantle over back of neck; shell spiral.

I. *SUB-ORDER.*—PROBOSCIDIFEROUS-PECTINIBRANCHS (Proboscidifera).

Head with a long retractile proboscis; tentacles close together at their origin; eyes sessile at their outer bases. Carnivorous.

1. FAMILY.—*Rock-Shells* (Muricidæ). Teeth in three rows; mantle with a long straight siphon; foot simple in front; shell with a more or less elongated canal at fore part of aperture; whorls with varices.
2. FAMILY.—*Trumpet-Shells* (Tritonidæ). Teeth in seven rows; mantle enclosed, with a straight siphon; shell with irregular or few varices on the whorls; aperture with an elongated siphonal canal.
3. FAMILY.—*Whelks* (Buccinidæ). Mantle enclosed;

siphon short, recurved; foot simple in front; shell without varices on whorls; aperture with no canal but an oblique notch at the fore part.

4. Family.—*Olives* (Strephonidæ). Mantle enclosed; siphon recurved; foot fissured on each side in front, the margins reflexed on shell; shell with last whorl enrolled round the others, polished; aperture with an oblique notch in front. (*Olividæ*, Auct.)

5. Family.—*Tulip-Shells* (Fasciolariidæ). Mantle enclosed; siphon straight; lateral teeth not versatile as in *Muricidæ*, but broad and multidentate; shell without varices on whorls; siphonal canal straight; columella with plaits on fore part.

6. Family.—*False-Volutes* (Vasidæ). Mantle enclosed; siphon straight; lateral teeth narrow, with a single large denticle; shell with the aperture channelled in front; pillar with plaits on the middle. (*Turbinellidæ*, Gray.)

7. Family. *Volutes-proper* (Volutidæ). Siphon short, recurved, with auricles on each side at base; tentacles far apart, united by a veil over the head; shell with apex of spire mammillated; columella with plaits.

8. Family—*Mitres* (Mitridæ). Siphon simple at base; tentacles close together at base; mantle enclosed; foot small; shell with apex of spire acute; columella with plaits.

9. Family.—*China-Shells* (Porcellanidæ). Siphon

simple at base; tentacles close together at base; mantle-lobes expanded, covering sides of shell; operculum none; shell polished, with plaits on pillar; margin of outer lip thickened. (*Marginellidæ*, Auct.)

10. FAMILY.—*Fissure-Shells* (Turritidæ). Siphon straight; mantle with a slit on hind part of right side; shell turreted; aperture with a straight canal in front; outer lip with a fissure or sinus at hind part of margin. (*Pleurotomidæ*, Gray.)

11. FAMILY.—*Tun-Shells* (Doliidæ). Mantle enclosed; siphon recurved; foot small; operculum none; shell thin, ventricose, witl transverse ribs or grooves; aperture with an oblique notch in front.

12. FAMILY.—*Fig-Shells* (Sycotypidæ). Mantle with expanded lobes covering sides of shell; siphon produced; operculum none; shell light, ventricose; aperture with a produced canal; whorls with transverse ribs. (*Ficula*, Swains.)

13. FAMILY.—*Velvet-Ears* (Velutinidæ). Eyes on outer side of tentacles; margin of mantle inflated, folded on the edge into two canals; operculum none; shell thin, turbinate, covered with a velvety epidermis; aperture wide, simple in front.

14. FAMILY.—*Dwarf-Ears* (Otinidæ). Tentacles obsolete; eyes on upper part of head; mantle enclosed; foot divided by a transverse

fissure into two creeping disks; operculum none; shell ear-shaped, spire minute; aperture large.

15. FAMILY.—*Coriocellus* (Lamellariidæ). Eyes at bases of tentacles; mantle very large, entirely covering the shell, notched in front; operculum none; shell thin, semi-pellucid, ear-shaped; aperture wide.

16. FAMILY.—*Sea-Snails* (Naticidæ). Eyes none; mantle enclosed; foot very large, produced in front, operculigerous, lobe greatly developed, partly covering the shell; operculum sub-spiral; shell smooth, spiral; aperture semi-lunar, entire in front.

17. FAMILY.—*Helmet-Shells* (Cassididæ). Teeth numerous, similar, in many rows; mantle enclosed, with a recurved siphon; operculum annular; shell ventricose, whorls often variced; aperture with a recurved canal, or a notch in front; outer lip thickened.

18. FAMILY.—*Wentletraps* (Scalidæ). Mantle enclosed, without a siphon; foot moderate; eyes on outer side of tentacles; operculum horny, spiral; shell turreted, variced; aperture round, without any canal.

19. FAMILY.—*Awl-Shells* (Terebridæ). Mantle enclosed, with an elongated siphon; eyes on tip of tentacles or wanting; tentacles small; foot small; operculum annular, nucleus apical; shell turreted; outer lip thin, not variced. (*Terebrina*, Mörch; *Acusidæ*, Gray.)

20. **Family.** — *Pyramid-Shells* (Pyramidellidæ). Tentacles ear-shaped; eyes on their inner sides; mantle enclosed; foot moderate; shell turreted; columella plicated.

21. **Family.** — *Eulimas* (Eulimidæ). Tentacles simple, subulate; eyes on their outer bases; mantle enclosed; foot moderate; shell turreted; columella simple.

22. **Family.**—*Star-fish Parasites* (Stylinidæ). Foot greatly produced in front; tentacles subulate, simple; eyes on their outer bases; mantle enclosed; shell globose or turreted; aperture oblong; columella simple. Parasitic on Star-fishes.

23. **Family.** — *False Club-Shells* (Cerithiopsidæ). Eyes on centre of tentacles at their base; mantle enclosed, with a short siphon; foot grooved beneath; operculum with the nucleus apical; shell turreted, granular; aperture with a short anterior canal.

24. **Family.** —*Staircase-Shells* (Architectonicidæ). Tentacles folded, with the suture below; eyes sessile on upper surface of their base; tentacles close together at their base; foot small; operculum ovate or circular; shell trochiform, with a wide umbilicus. (*Solarium*, Lamck.)

II. *SUB-ORDER.*—ROSTRIFEROUS-PECTINIBRANCHS (Rostrifera).

Head with a non-retractile rostrum; tentacles subulate, wide apart, on the sides of the rostrum. Mostly phytophagous.

25. FAMILY.—*Wing-Shells* (Strombidæ). Eyes on the end of cylindric peduncles, with the tentacles on their middle; mantle with outer margin lobed; foot divided, formed for leaping not walking; operculum claw-like; shell with the outer lip expanded, notched near the fore part, changing in form with age. Marine.

26. FAMILY.—*Auger-Shells* (Terebellidæ). Eyes on the end of cylindric peduncles; tentacles none; foot compressed, sub-ovate; operculum horny, tricuspid externally; shell subulate, involute; aperture linear, outer lip simple. Marine.

27. FAMILY.—*Cones* (Conidæ). Eyes near the ends of the tentacles; teeth barbed, in two rows; mantle enclosed; operculum ovate, nucleus apical; shell cone-shaped; aperture straight; outer lip simple.

28. FAMILY.—*False Wing-Shells* (Aporrhaidæ). Eyes sessile on outer bases of tentacles; mantle with the outer edge expanded or lobed; siphon bent to the right; foot simple; operculum annular, ovate; shell with the outer lip sinuous, lobed, or digitate.

29. FAMILY.—*Lattice-Shells* (Cancellariidæ). No tongue nor teeth; eyes sessile on outer bases of tentacles; mantle enclosed; siphon rudimentary; operculum none; shell spiral, whorls cancellated; columella with plaits. Marine.

30. FAMILY.—*Hair-Keels* (Trichotropidæ). Teeth in seven rows; tongue short and broad; eyes on lower halves of tentacles; mantle with a rudimentary siphon; operculum ovate, annular; shell spiral; aperture nearly simple in front; columella without plaits.

31. FAMILY.—*Coral-Parasites* (Pediculariidæ). Eyes on outer bases of tentacles; mantle enclosed, simple in front; operculum none; shell non-spiral; apex lateral; aperture very wide; columella simple; outer lip thin.

32. FAMILY.—*Egg-Shells* (Amphiperatidæ). Lateral teeth pectinate; mantle lobes expanded, covering the sides of the shell, bearded externally; operculum none; shell porcellanous, smooth; outer lip with the edge inflexed. (*Ovulum*, Lamck.)

33. FAMILY.—*Cowries* (Cypræidæ). Outer lateral teeth conical; eyes sessile on outer bases of tentacles; mantle-lobes expanded, covering the shell; operculum none; shell involute, the last whorl enrolling and concealing all the others; spire none; columella toothed.

34. FAMILY.—*Carriers* (Onustidæ). Eyes sessile on outer bases of tentacles; mantle simple in front; foot compressed, formed for jumping not walking; operculum horny, sub-annular; shell trochiform; whorls more or less covered with fragments of shells, &c. (*Phoridæ*, Gray; *Xenophoracea*, Phil.)

35. FAMILY.—*Chambered-Shells* (Calyptridæ). Eyes

sessile at base of tentacles; gills placed obliquely across neck; foot expanded, simple; operculum none; shell conical, non-spiral; aperture wide, with an internal testaceous appendage.

36. **FAMILY.**—*Bonnet-Shells* (Capulidæ). Eyes on outer bases of tentacles; gills placed obliquely across neck; foot folded on itself; operculum none; shell simple, cap-shaped; aperture wide, simple internally. Marine.

37. **FAMILY.**—*White-Ears* (Vanicoridæ). Eyes sessile on outer bases of tentacles; foot small; circular, winged at the sides, and with a narrow lobe in front; operculum ovate, horny; shell spiral, white; last whorl large; aperture semi-lunar. Marine. (*Naricacea*, Phil.)

38. **FAMILY.**—*Worm-Shells* (Vermetidæ). Eyes sessile on outer bases of short tentacles; foot cylindrical, produced and truncate in front, not fit for walking; operculum circular, spiral; shell attached, tubular, irregularly spiral. Marine.

39. **FAMILY.**—*False Tooth-Shells* (Cæcidæ). Eyes sessile on the head behind bases of tentacles; foot short; operculum circular; shell many-whorled, sub-cylindrical, arched; apex sub-spiral, deciduous. Marine.

40. **FAMILY.**—*Apple-Snails* (Ampullariidæ). Tentacles subulate; eyes on peduncles at their outer bases; mantle with a siphon; rostrum

bilobate, lobes subulate; operculum annular, regular; shell turbinate, thin; aperture entire in front. Fluviatile.

41. FAMILY.—*River-Snails* (Viviparidæ). Eyes sessile on outer bases of tentacles; rostrum entire; mantle simple in front; operculum annular, regular; shell turbinate, covered with an epidermis; aperture entire in front. Fluviatile. (*Paludinacea*, Phil.)

42. FAMILY.—*Valve-Shells* (Valvatidæ). Eyes sessile on outer sides of tentacles; siphon none; gills plumose, exposed, protected by a long, slender lobe; operculum spiral, many-whorled; shell spiral, turbinate or discoidal; aperture entire. Fluviatile.

43. FAMILY.—*Periwinkles* (Littorinidæ). Eyes sessile on outer side of tentacles; mantle-margin with a slight siphonal fold; operculum subspiral; shell turbinate; aperture simple in front. Marine.

44. FAMILY.—*Rissoas* (Rissoidæ). Eyes on outer bases of tentacles; rostrum adnate to fore part of foot; mantle simple in front; operculigerous lobe with tentacular appendages; shell spiral, white, more or less turreted; aperture entire in front. Marine.

45. FAMILY.—*Quoyias* (Planaxidæ). Eyes sessile on outer bases of tentacles; mantle with a siphon in front; foot with the sides simple; operculum sub-spiral; shell turreted, with a notch at fore part of aperture. Marine.

46. **Family.**—*Sargassa-Shells* (Litiopidæ). Eyes sessile on outer bases of tentacles; mantle with a siphon in front; foot with tentacular filaments on the sides; operculum sub-spiral; shell sub-turreted; aperture with a distinct notch in front. Marine.

47. **Family.**—*Salt-Water Clubs* (Cerithiidæ). Eyes on outer sides of tentacles; mantle with a siphonal fold or a distinct siphon in front; operculum ovate, sub-spiral; outer lateral teeth conical, curved; shell turreted; aperture more or less beaked and channelled in front; outer lip expanded. Marine.

48. **Family.** — *Fresh-water Clubs.* — (Melaniidæ). Eyes sessile on outer bases of tentacles; mantle margin fringed, with a slight siphonal fold in front; operculum sub-spiral; lateral teeth multicuspid; shell spiral, many-whorled, covered with an epidermis; aperture usually simple in front. Fluviatile.

49. **Family.**—*Screw-Shells* (Turritellidæ). Tongue very short, minute; eyes on bulgings at outer bases of tentacles; mantle-margin fringed, nearly entire in front; a single long branchial plume; operculum circular, multispiral, edges of whorls fimbriated; shell turreted, many-whorled; aperture simple in front. Marine.

50. **Family.**—*Rissoellas* (Rissoellidæ). Eyes sessile, far back behind tentacles; rostrum bifid, lobes nearly as long as tentacles; opercu-

lum annular, with an internal process; shell spiral, hyaline, sub-turreted; aperture entire in front. Marine.

51. FAMILY.—*Macgillivrayias* (Macgillivrayiidæ). Tentacles four (?), nearly equal; eyes—(?); mantle with an elongate siphon in front; foot large, produced behind; a float (?); operculum annular, with an internal process; shell spiral, sub-globose, horny, sub-pellucid. Pelagian.

52. FAMILY.—*Oceanic-Snails* (Ianthinidæ). Tentacles subulate, with pedicles at their outer bases; eyes none; foot small, flat, with a vesicular appendage on hind part; shell thin, turbinate, violet; aperture sub-quadrate; columella straight; outer lip notched. Oceanic.

II. ORDER.—SCUTIBRANCHS (Scutibranchiata).

Gills of two series of lamellæ, forming one or two series over back of neck, or on under edge of mantle round foot; shell spiral, or symmetrical and conical.

I. *SUB-ORDER.*—PEDUNCLE-EYED SCUTIBRANCHS (Podophthalmata).

Eyes pedicelled, separate from the tentacles; teeth numerous, lateral ones reniform, very numerous, crowded.

1. FAMILY.—*Wreath-Shells* (Turbinidæ). Foot with

a lateral fringe ; head-lobes developed ; shell turbinate, pearly within ; operculum calcareous.

2. FAMILY.—*Top-Shells* (Trochidæ). Foot with a lateral fringe ; head-lobes rudimentary ; shell conical, spiral, pearly within ; operculum horny.
3. FAMILY.—*False-Ears* (Stomatellidæ). Foot with a lateral fringe ; front edge of mantle entire ; muscular impression crescentic ; shell ear-shaped, imperforate, pearly within ; operculum none or rudimentary.
4. FAMILY. — *Sea-Ears* (Haliotidæ). Foot with a lateral fringe ; head-lobes developed ; mantle with the front edge fissured ; muscle of attachment oval, central ; shell ear-shaped, pearly within, with a series of holes ; operculum none.
5. FAMILY.—*Nerites* (Neritidæ). Foot simple, without a lateral fringe ; head-lobes none ; shell spiral, turbinate, not pearly within ; operculum sub-spiral, calcareous, with an internal process.

II. *SUB-ORDER.*—SESSILE-EYED SCUTIBRANCHS (Edriophthalmata).

Eyes sessile, or on a slightly-raised tubercle on outer side of base of tentacles ; shell (adult) symmetrical, conical, not spiral, not pearly within ; operculum none.

6. FAMILY.—*Fissure-Limpets* (Fissurellidæ). Gills two, symmetrical, on back of neck; foot dilated; sides with a series of short tentacles; shell conical; apex perforate, or margin fissured.

7. FAMILY.—*Tooth-Shells* (Dentaliidæ). Head without tentacles or eyes; foot small, conical; sides simple; shell elongate, conical; apex perforate.

8. FAMILY.—*False-Limpets* (Tecturidæ). Gill single, on side of back of neck; foot with a simple groove on the sides; tentacles simple; shell conical, simple.

9. FAMILY.—*Blind-Limpets* (Lepetidæ). Gills two, pinnate, on back of neck; tentacles subulate; eyes none or rudimentary; shell conical, simple.

10. FAMILY.—*Groove-Limpets* (Gadiniidæ). Gills simple, placed obliquely across back of neck; tentacles folded, expanded; eyes sessile on middle of their bases; shell conical, with a groove for vent in front of right side.

11. FAMILY.—*True-Limpets* (Patellidæ). Gill under edge of mantle, forming a more or less complete ring round the body; tentacles subulate; shell conical, simple.

12. FAMILY.—*Chitons* (Chitonidæ). Gills in two series, one on each side of hind part of body; head covered by a hood, formed of the united tentacles; eyes none; shell formed of eight imbricate pieces along the back.

II. *SUB-CLASS.*—OPISTHOBRANCHIATE-GASTEROPODS (Opisthobranchiata).

Heart placed before gills; gills plume-like, on the side under the mantle, or arranged along the back, exposed.

I. ORDER.—TECTIBRANCHS (Tectibranchiata).

Gill forming a plume on the side under a fold of mantle, usually protected by a shell.

1. FAMILY. — *Umbrella-Shells* (Pleurobranchidæ). Tentacles ear-shaped; eyes sessile on their inner bases; gill on the side, under mantle; shell external or internal, membranous or calcareous.
2. FAMILY.—*Sea-Hares* (Aplysiidæ). Tentacles separate, ear-like; eyes sessile on head; foot with large lateral lobes, usually folded across back; shell internal.
3. FAMILY. — *Long-tailed Bullas* (Lophocercidæ). Tentacles distinct, ear-like; eyes sessile; organs of generation close together in one tubercle; shell external, partly covered by lobes of foot.
4. FAMILY.—*Bullæas* (Philinidæ). Tentacles forming a square frontal disk with lobes; eyes none; shell concealed in substance of mantle.
5. FAMILY.—*Bubble-Shells* (Bullidæ). A tentacular frontal disk, notched behind; eyes sessile on the middle; foot-lobes covering sides of shell; mouth of shell entire in front.

6. Family.—*Banded Bubble-Shells* (Aplustridæ). Frontal disk produced into ear-like tentacles; eyes at their bases; operculum none; shell with mouth channelled in front.
7. Family.—*Cylindric-Bullas* (Cylichnidæ). Tentacles broad, flattened, lateral, recumbent; eyes on their inner bases; foot short; shell external, cylindric, with a plait on columella.
8. Family.—*Turned-Shells* (Acteonidæ). Head depressed, with broad posterior tentacular lobes; eyes sessile on middle of head; an operculum; shell with the columella plicate.

II. ORDER.—Nudibranchs (Nudibranchiata).

Gills exposed, or contractile into cavities of mantle; shell only present in the larva state.

I. *SUB-ORDER.*—Anthobranchs (Anthobranchiata).

Gills surrounding vent, on middle of hind part of back.

1. Family.—*Dorids* (Dorididæ). Gills in a common cavity; mantle-edge simple; teeth many in each cross series, sub-similar, inner often smaller.
2. Family.—*False-Dorids* (Onchidorididæ). Gills in separate cavities; mantle edging the foot and simple; teeth two in each cross series.
3. Family.—*Clubbed-Dorids* (Triopidæ). Gills in a common cavity; mantle small, edged with tentacles; teeth many (rarely only four) in

each cross series, inner lateral ones large, irregular.

II. *SUB-ORDER.*—Aiolobranchs (Aiolobranchiata).

Gills superficial, generally in the form of fusiform processes, plaits, or branching vessels.

4. Family. — *Tritonias* (Dendronotidæ). Tongue broad; teeth many in each cross series; jaws horny; tentacles sheathed; gills fusiform or branched, on each side of back; vent lateral.
5. Family.—*Antiopas* (Proctonotidæ). Tongue broad, teeth many in each cross series jaws horny; tentacles simple, linear, not sheathed; gills fusiform, on sides of back; vent dorsal.
6. Family.—*Pleurophyllidians* (Pleurophyllidiidæ). Tongue broad; teeth many in each cross series; jaws horny; tentacles simple, united, expanded; gills in folds, on under side of mantle-margin, which is bent up.
7. Family.—*Dotos* (Dotonidæ). Tongue narrow; teeth in a single central series; tentacles sheathed at base, retractile; gills fusiform, on sides of back.
8. Family.—*Eolids* (Eolididæ). Tongue narrow; teeth in a single central series; tentacles subulate, simple, rarely ringed; contractile; gills fusiform or branched, on sides of back; jaws horny.
9. Family.—*Hermæas* (Hermæidæ). Tongue nar-

row; teeth in a single series; tentacles none, rudimentary or folded; gills on side of back; vent dorsal or sub-lateral; jaws none.

10. FAMILY.—*Elysias* (Elysiidæ). Tongue narrow, teeth in a single series; tentacles subulate or linear; gills in the form of plaits or vessels radiating on surface of back.

11. FAMILY.—*Sea-Slugs* (Limapontiidæ). Tongue narrow; teeth in a single series; tentacles none or simple, contractile; body depressed; gills none external.

12. FAMILY. — *Oceanic - Slugs* (Phyllirrhoidæ). Tongue narrow; teeth in a single series; jaws horny; tentacles elongate, subulate, simple; body compressed vertically; gills none external.

13. FAMILY.—*Phyllidians* (Phyllidiidæ). Tongue and jaws none; tentacles dorsal, anterior, retractile; labial palpi close, conical, small; gills in form of radiating folds, on under side of mantle-margin; vent medial, posterior.

III. *SUB-CLASS.*—HETEROPODOUS-GASTEROPODS (Heteropoda).

Gills tufted, on inner edge of front of mantle; foot various, modified and compressed for swimming.

1. FAMILY.—*Carinarias* (Pterotracheidæ). Body elongated, gelatinous; eyes large, sessile; gills in a small sac, naked, or covered with a thin sub-spiral shell; operculum none.

2. FAMILY.—*Sea-Arrows* (Sagittidæ). Head with-

out eyes or tentacles; gills none external; body elongated, furnished with fins or swimming lobes; shell and operculum none.

3. FAMILY.—*Pterosomes* (Pterosomatidæ). Body gelatinous, transparent, sub-cylindrical, with a large thin horizontal wing-like fin on each side; eyes sessile; tentacles none; shell none.

4. FAMILY.—*Atalants* (Atlantidæ). Head with subulate tentacles; eyes sessile on sides of head; body spiral, enclosed in a shell; foot with the front part in form of a vertical fin; hind part narrow, horizontal, operculigerous; shell spiral, transparent, carinated.

IV. *SUB-CLASS.*—PULMONIFEROUS-GASTEROPODS (Pulmonifera).

Breathing organ in form of an air-sac or dorsal cavity lined by a vascular net-work; mouth with transverse jaws; respiring free air; phytophagous; larva without cephalic fins.

I. ORDER.—ADELOPNEUMONS (Adelopneumona).

Edge of mantle united to nape, covering pulmonary cavity except at a lateral aperture; hermaphrodite; operculum none.

I. *SUB-ORDER.*—TERRESTRIAL-PULMONIFERS (Geophila).

Eyes at apex of elongated cylindrical peduncles;

tentacles cylindrical, shorter than and under eye-peduncles. Living on the land.

1. FAMILY.—*Water-loving Slugs* (Onchidiidæ). Eye-peduncles contractile (not retractile), eyes at their ends; body covered with a large coriaceous mantle; shell none.
2. FAMILY.—*Burrowing-Slugs* (Testacellidæ). Eye-peduncles retractile; mantle usually concealed under shell; breathing orifice on hind part of mantle; shell external, small, on hind part of body.
3. FAMILY.—*True-Slugs* (Limacidæ). Eye-peduncles retractile; mantle shield-shaped, covering the shell; breathing orifice on right side; caudal gland none; shell rudimentary, internal.
4. FAMILY.—*Arions* (Arionidæ). Eye-peduncles retractile; mantle shield-shaped, covering the shell; breathing orifice on right side; foot with a distinct caudal gland near the end; shell internal, rudimentary, or external and well developed.
5. FAMILY.—*Snails* (Helicidæ). Eye-peduncles retractile; mantle lining the shell; caudal gland none; shell external, spiral, well-developed.
    1. *Buliminæ.* Aperture of shell longer than wide, columella not truncate; spire elevated.
    2. *Helicinæ.* Aperture of shell wider than long; columella simple in front; spire moderate.

3. *Achatininæ.* Aperture of shell longer than wide; columella truncate; spire more or less elevated.
4. *Vitrininæ.* Animal not completely retractile within the shell; shell thin, transparent.

II. *SUB-ORDER.*—FRESH-WATER PULMONIFERS (Limnophila).

Eyes sessile; tentacles sub-cylindrical or flattened, simply contractile; operculum none.

6. FAMILY.—*Pond-Snails* (Limnæidæ). Tentacles contractile, flattened; eyes sessile on their inner bases; shell horn-coloured; aperture without plaits. Fluviatile.
7. FAMILY.—*Marsh - Volutes* (Auriculidæ). Tentacles contractile; eyes sessile on nape at inner sides of bases of tentacles; shell with the aperture plaited. Terrestrial, or living in marshes.

III. *SUB-ORDER.*—MARINE-PULMONIFERS (Thalassophila).

Eyes sessile on front part of frontal disk formed by the expanded tentacles. Living on the shores or in salt marshes.

8. FAMILY.—*Siphon-Shells* (Siphonariidæ). Tentacles forming a large bilobed frontal disk; mantle with a fleshy lobe on right side covering the respiratory aperture; shell coni-

cal, simple, with an internal groove on middle of right side; operculum none.

9. FAMILY.—*Amphibolans* (Amphibolidæ). Tentacles forming by their union a large frontal disk with the eyes sessile on the fore part; shell spiral, turbinate; outer lip notched in the middle; operculum horny.

II. ORDER.—PHANEROPNEUMONS (Phaneropneumona).

Edge of mantle free from nape, leaving the pulmonary cavity open; operculum distinct; animal unisexual.

I. *SUB-ORDER.*—OPISOPHTHALMIANS (Opisophthalmata).

Eyes sessile on upper part of head behind base of tentacles.

1. FAMILY.—*Looping-Snails* (Truncatellidæ). Eyes sessile behind base of tentacles; tentacles subulate; foot divided across; operculum horny, sub-spiral; shell turreted, spiral.

II. *SUB-ORDER.*—ECTOPHTHALMIANS (Ectophthalmata).

Eyes placed on sides of head at outer base of tentacles; operculum horny or testaceous.

2. FAMILY.—*Cyclostomes* (Cyclophoridæ). Eyes at outer base of tentacles; foot moderate; operculum spiral; shell with the aperture circular.

3. FAMILY.—*Helicines* (Helicinidæ). Eyes at outer bases of tentacles; foot elongate; operculum annular; shell with the aperture semi-lunar.

BIVALVES.

The *Conchifera*, comprising the Bivalve Mollusks, have the sides of their mantle protected by shelly valves, which, however, are not spiral as in the Gasteropods, but simply concave and united together by a horny ligament. The *Conchifera* are without any apparent head, nor are they possessed of either eyes or tentacles. There is usually a pair of gills between the mantle and the body on each side; and the foot, although attached to the belly, does not form a flattened disk as in the Gasteropods, but is laterally compressed, allowing the animals to leap or burrow, but not serving as an organ of reptation. The mantle, in many of the families, is posteriorly prolonged into two siphons or tubes, the upper one of which is anal and excretory, and the lower one branchial or respiratory; in other families the siphonal tubes are entirely wanting. Some Bivalve Mollusks swim freely about by alternately closing and expanding their valves, as the Pectens, which have hence been termed the "butterflies of the deep;" others, on the contrary, are securely anchored to foreign bodies at the bottom of the sea, as the Clam-shells and the Oysters; while others, as the Venuses and Cockles, are enabled to move about on the surface of the sand by placing their bent foot under their shells and suddenly straightening it, causing it to act like a lever. Some *Conchifera* bury themselves with great facility in the mud or sand by means of their long conical muscular foot, as the Razor-fish, the Gapers, and the fresh-water Pearl-Mussels; some again are loosely attached to sub-marine rocks by a long byssus, as the Mussels and Pinnas, in which case the foot, being useless, is rudimentary or obsolete. Others perforate stones, as the *Pholades*, or wood, as the Ship-worms or *Teredines*, which are often very destructive to the bottoms of vessels, and do much mischief in dockyards to timber. Many Bivalves are excellent articles of diet, as the Scallop and the Cockle; nor must that epicurean morsel be omitted, the much-prized Oyster; other Conchiferous shell-fish are important in a commercial point of view, on account of the pearly nature of their shells, and the globules of free nacre they sometimes secrete, as the Pearl-Oysters.

IV. CLASS.—BIVALVES (Conchifera).

Head indistinct; body covered with a bilobed mantle, each lobe protected by a shelly valve; gills lamellar, two on each side; foot usually compressed and keeled; mouth with elongate fleshy lips; valves of shell united on their dorsal edges by a ligament. Aquatic.

I. *SUB-CLASS.*—BIMUSCULAR-BIVALVES (Dimyaria).

Animal with two nearly equal adductor muscles for closing the valves.

I. ORDER.—PHYLLOPODS (Phyllopoda).

Foot lamellar or elongate; gills not produced into anal siphon; mantle-lobes more or less disunited; siphons elongate, usually separate at their ends.

1. **Family.**—*Venuses* (Veneridæ). Siphons short, united for the greater part of their length; foot large, compressed; shell regular, closed; hinge with three diverging cardinal teeth; ligament external. Marine.
2. **Family.**—*Cyprinas* (Cyprinidæ). Siphons very short; mantle-lobes free beneath; shell ovate, cordate, covered with an epidermis; hinge-teeth 3–3; anterior lateral teeth none; siphonal inflection none or rudimentary.
3. **Family.**—*Glauconomes* (Glauconomidæ). Shell oblong, covered with a green epidermis; hinge-teeth 3–3, in right valve the hinder elongate and bifid, in left valve the hinder small and laminar; lateral teeth none.
4. **Family.**—*Rock-Borers* (Petricolidæ). Siphons elongated, separate; foot small, lanceolate, with a byssal groove; shell boring, gaping, often irregular; ligament external; hinge-teeth large and irregular.
5. **Family.**—*Cyrenoids* (Cyrenoididæ). Mantle-lobes free beneath, with two united siphons; gills two on each side; shell oblong, ventricose, covered with a thin epidermis; cardinal teeth 3–3; siphonal inflection none.
6. **Family.**—*Freshwater-Venuses* (Corbiculidæ). Siphons produced, more or less united; foot large, linguiform; shell tumid, covered with

an epidermis; ligament external; hinge with cardinal and lateral teeth. Fluviatile.

7. FAMILY.—*Paphians* (Paphiidæ). Shell variable in form; ligament internal; pallial impression sinuated; hinge with the anterior cardinal tooth simple, compressed.

8. FAMILY.—*Mactras* (Mactridæ). Siphons united to their extremities, which are fringed; foot linguiform, geniculate; shell with the cartilage internal; two cardinal teeth in each valve, the anterior usually bifid.

9. FAMILY. — *Anatinellas* (Anatinellidæ). Shell oblong, rather gaping behind, equivalve, covered with an epidermis; cartilage internal, in a pit; lateral teeth none; siphonal inflection none.

10. FAMILY.—*Tellens* (Tellinidæ). Siphons long, slender, entirely separate; foot broad, geniculate; shell regular; hinge with two primary teeth in each valve; ligament external; siphonal inflection deep.

11. FAMILY.—*Mud-Mactras* (Scrobiculariidæ). Orifices of siphonal tubes plain; mantle-margin toothed; foot large, compressed; shell slightly gaping posteriorly; hinge with an internal cartilage situated in a pit.

12. FAMILY.— *Wedge-Shells* (Donacidæ). Mantle freely open in front; siphons separated to their bases; foot large, sharp-edged, with a byssal groove; shell variable in form, more or less wedge-shaped; hinge with primary teeth.

II. ORDER.—CLADOPODS (Cladopoda).

Foot large and club-shaped, often truncate and expanded at the end; mantle-lobes usually united, with a passage in front for the foot; siphons large, produced, generally united to their ends; gills produced into the anal siphon.

1. FAMILY.—*Borers* (Pholadidæ). Siphons greatly prolonged, united as far as their ends; foot club-shaped, truncate at end; shell free, or within a tube, without ligament, and with apophyses under the beaks; often with supplemental valves.
2. FAMILY.—*Tube-Shells* (Gastrochænidæ). Siphons very long, united almost to their ends and fimbriated; foot small, digitiform; shell equivalve, often gaping, incrusted in whole or partly, or free in a tube, which is either free or enclosed; no apophyses at the hinge.
3. FAMILY.—*Razor-fish* (Solenidæ). Siphons short, united; orifices fimbriated; foot elongated, thick, club-shaped, truncated; shell subcylindrical, greatly elongated transversely, gaping at each end; hinge with two or three teeth in each valve, the hinder bifid, cartilage external, on a pad or fulcrum.
4. FAMILY.—*Pod-Shells* (Pharidæ). Siphons separated for more than half their length; foot ovate, elongate, truncated; shell greatly elongated transversely, gaping at each end; ligament external; hinge simple, or with one or two hooked teeth.

5. FAMILY.—*Lantern-Shells* (Laternulidæ). Siphons slender, separated, with fringed orifices; foot small; mantle almost entirely closed; shell inequivalve, gaping at the hinder extremity; ligament internal; usually a free ossicle at the hinge; a siphonal inflection.
6. FAMILY.—*Arctic-Gapers* (Glycimeridæ). Siphons elongated, united; mantle-lobes united; shell more or less gaping at the sides, transversely elongated; ligament large, prominent, external, on a fulcrum; hinge simple or with a few primary teeth.
7. FAMILY. — *Gapers* (Myidæ). Siphons greatly elongated, united to their ends; foot small; mantle almost entirely closed; shell oblong, gaping at the extremities; cartilage in a spoon-shaped cavity in one of the valves; hinge edentulate; no free ossicle.
8. FAMILY. — *Pearly-Gapers* (Pholadomyidæ). Mantle-lobes united; siphons none; an opening under siphonal orifice; foot bifurcate; shell transverse, pearly within, gaping posteriorly; hinge without teeth; ligament external.
9. FAMILY.—*Pod-Gapers* (Solenomyidæ). Mantle almost entirely open, with a single cirrhated orifice behind; foot cylindrical, truncate, ending in a fimbriated disk; shell transversely oblong, with a thick epidermis extending beyond the margins; hinge with a cardinal tooth in each valve.

10. FAMILY.—*Galeommas* (Galeommidæ). Mantle very large, double-edged, tubercled, almost entirely open, with a single aperture at hind part; foot long, ligulate, perforate, byssiferous; shell thin, equivalve, transversely oval, entire, ventral margin gaping; hinge edentulate; ligament internal.

11. FAMILY. — *Pandoras* (Pandoridæ). Siphons short, united nearly to their ends, ends divergent, fringed; shell equivalve, pearly within; ligament internal, hinge often with an internal ossicle.

12. FAMILY.—*Corbulas* (Corbulidæ). Siphons very short, united, ends fringed, and with a membranous tube; mantle almost entirely open; foot narrow; shell inequivalve, beaked anteriorly; hinge with primary teeth in one or both valves; cartilage in an internal pit.

13. FAMILY.—*Stone-Borers* (Saxicavidæ). Mantle closed except for passage of foot; siphons elongate, united; foot byssiferous; shell irregular, gaping at ventral margin; hinge with a few primary teeth.

14. FAMILY.—*Laseas* (Laseidæ). Mantle with only one (anal) opening, folded anteriorly into a canal or tube; foot ligulate, grooved, byssiferous; shell small, tumid or compressed; ligament and teeth variable.

15. FAMILY.—*Scale-Shells* (Leptonidæ). Mantle-margin extending beyond the shell and cirrhated; siphon short; foot keeled and disked;

shell orbicular, compressed, gaping at the sides; pallial impression simple.

III. ORDER.—Goniopods (Goniopoda).

Foot angular, more or less compressed; siphons none or rudimentary; mantle-lobes more or less united.

1. Family.—*False-Cockles* (Carditidæ). Lobes of mantle disunited in their entire length, with a single posterior opening; foot compressed, with a byssal groove; shell closed, regular, free; hinge with one or two oblique cardinal teeth, lateral teeth none.
2. Family.—*Chamas* (Chamidæ). Two short siphons beset with cirrhi; lobes of mantle united behind; foot small, cylindrical, truncate; shell irregular, porcellanous, attached, inequivalve, with a single large hinge-tooth; pallial impression not sinuated.
3. Family.—*Cockles* (Cardiidæ). Siphons short, their bases beset with cirrhi, margins fringed; foot large and geniculate; shell cordate, with radiating ribs and furrows; hinge usually with two primary teeth in each valve, and distinct lateral teeth; pallial impression not sinuated.
4. Family.—*Heart-Cockles* (Glossidæ). Mantle-lobes united behind, with two short siphons; foot small, sub-angular, compressed, and trenchant; shell symmetrical, heart-shaped, ventricose; beaks spirally inrolled; hinge

with two primary teeth in one valve and three in the other; ligament internal.

5. FAMILY.—*Astartes* (Astartidæ). Mantle almost entirely open; siphons rudimentary, consisting of two scarcely separated orifices; foot thick, hatchet-shaped, without a byssus; shell thick, closed; hinge with primary teeth; ligament external; pallial impression nearly entire.

6. FAMILY.—*Crassatellas* (Crassatellidæ). Animal ——? shell with the valves closed; hinge with two cardinal teeth; lateral teeth none; cartilage in an internal triangular pit.

7. FAMILY.—*Lucinas* (Lucinidæ). Mantle-lobes half united, with two openings at the hind part; foot cylindrical, folded on itself, hollow, the tube opening into the visceral cavity; shell more or less orbicular; ligament external or sub-internal; muscular scars large.

8. FAMILY.—*False-Lucinas* (Diplodontidæ). Mantle-margins united except for a large inferior opening for foot, and a small posterior anal opening without any siphon; foot vermiform; shell irregular, closed, with cardinal teeth in each valve.

9. FAMILY.—*Arks* (Arcidæ). Mantle freely open; siphons none; gills of separate filaments; foot bent, grooved, with slightly crimped margins; shell not pearly within, closed or gaping at ventral margin; hinge multidentate, teeth interlocking.

10. FAMILY. — *Solen-Arks*: (Solenellidæ). Mantle open the entire length, margin double, with a single anal siphon; labial palps elongate; foot compressed, geniculate, with a disk with crenate margins; shell thin, gaping slightly posteriorly, not pearly within; hinge-margin with comb-like teeth; ligament external, prominent.

11. FAMILY. — *Pearly-Arks* (Nuculidæ). Mantle completely open, with or without siphonal tubes; one of the labial palps curled, with fimbriated margins; gills foliaceous; foot deeply grooved, forming an ovate disk with serrated margins; shell pearly within; teeth comb-like; ligament internal.

12. FAMILY.—*Cockle-Arks* (Trigoniidæ). Mantle-lobes free, prolonged into short siphons; gills foliaceous; foot large, geniculate, with a disk; shell equivalve, with radiating ribs, pearly within; hinge with a few broad, lamelliform, grooved teeth interlocking with each other.

13 FAMILY. — *Pond-Mussels* (Unionidæ). Mantle freely open, branchial orifice fringed, anal plain or tube-like; gills foliaceous; foot broad, compressed, without a byssal groove; shell pearly within, covered with an epidermis; hinge variable; ligament external. Fluviatile.

14. FAMILY. — *Nile-Mussels* (Mutelidæ). Mantle freely open, united behind and prolonged into two short siphons; gills foliaceous; foot

large, compressed; shell transverse, pearly within; hinge-margin tuberculated; ligament marginal, external. Fluviatile.

15. FAMILY.—*River-Solens* (Mycetopidæ). Mantle freely open; siphons none; foot long, cylindrical, produced, inflated at the end; shell thin, sub-cylindrical, gaping at both sides; beaks nearly central. Fluviatile.

16. FAMILY.—*River-Oysters* (Ætheriidæ). Lobes of mantle entirely disunited, prolonged into short siphons; gills foliaceous; foot large, thick, oblong; shell irregular, attached; hinge edentulous; ligament in a groove of beaks. Fluviatile.

IV. ORDER.—POGONOPODS (Pogonopoda).

Siphons indistinct or rudimentary; animal attached by a bundle of fibres arising from front of base of foot.

1. FAMILY.—*Mussels* (Mytilidæ). Mantle-margins more or less united; siphonal tubes distinct or wanting; gills foliaceous; foot small, narrow, byssiferous; shell elongated, equivalve; hinge simple or sub-dentate; ligament marginal, sub-internal; muscular scars unequal. Marine.

2. FAMILY. — *Fresh-water Mussels* (Dreissenidæ). Mantle closed; branchial opening tube-like, with a fringed orifice, anal sessile and plain; foot short, byssiferous; shell with the beaks

terminal; hinge usually edentulate, with a transverse septum. Fluviatile.

3. FAMILY.—*Pearl-Oysters* (Aviculidæ). Mantle freely open, margins cirrhated; foot small, cylindrical, with a byssal groove; shell foliated, irregular, pearly within, right valve with a notch for the byssus; hinge-margin straight; ligament marginal, simple or interrupted.

4. FAMILY.—*Pinnas* (Pinnidæ). Mouth with foliaceous lips; no separate posterior opening; anal siphon with a long ligulate valve; gills foliaceous; shell wedge-shaped, gaping at ventral margin, pointed at dorsal; hinge lateral, without teeth; ligament linear, almost internal.

5. FAMILY.—*Clams* (Tridacnidæ). Mantle closed, except for the branchial and anal orifices, and the aperture for the thick, cylindrical, byssiferous foot; shell regular, transverse, truncate; hinge with two compressed teeth; ligament external; muscular scars united, irregular.

II. *SUB-CLASS.*—UNIMUSCULAR-BIVALVES (Monomyaria).

Animal with a single adductor muscle for closing the valves.

I. ORDER.—MICROPODS (Micropoda).

Mantle-lobes entirely free; siphons none; foot rudimentary.

1. FAMILY.—*Scallops* (Pectinidæ). Mantle open in its entire length, with pendent tentacular edges, usually with eye-like spots; foot small, cylindrical, with a byssal groove; shell free, regular, not foliaceous, usually auricled; ligament in a cardinal groove.
2. FAMILY.—*Water-Clams* (Spondylidæ). Mantle-margins with truncate cirrhi; foot short, pedunculate, ending in a disk, with an elongate cylindrical tendon arising from its centre; shell irregular, attached; hinge with two strong teeth; ligament internal.
3. FAMILY.—*Oysters* (Ostreidæ). Mantle open in its entire length, without siphons, edges double bordered with cirrhi, no conspicuous ocelli; foot obsolete, rudimentary; shell irregular, attached, foliated; hinge without teeth; ligament internal or semi-internal.
4. FAMILY.—*Perforated-Oysters* (Anomiidæ). Mantle freely open, with cirrhated margins, no conspicuous ocelli; foot rudimentary; shell emarginate, or perforated near the beak, through which opening the adductor muscle passes, attached to an opercular shelly plug.
5. FAMILY.—*Window-Oysters* (Placunidæ). Shell compressed, thin, transparent; cartilages on the edge of two divergent ridges on one of the valves, which fit into grooves in the other.

BRACHIOPODS.

The Brachiopods are headless Mollusks like the *Conchifera*, and the foot is also wanting; they are, moreover, destitute of true gills, and appear to respire by means of their mantle. Their bodies are protected by two unequal, symmetrical, valves united by a hinge without a ligament; the under or ventral valve is sometimes attached, and the upper or dorsal is frequently perforated near the beak for the passage of a tendon, by means of which the animal is anchored to sub-marine bodies. The mantle-margins are disunited, but the great distinguishing feature of these remarkable creatures is the existence of two, strangely contorted or spiral, bony arms covered with a ciliated membrane, and arising from each side of the mouth. The ends of the spiral arms, in some genera, are endowed with voluntary motion, the movement being effected by the injection of a fluid into the hollow spiral tube by which the coils are separated. The peculiar bony apophysary skeleton exhibits various modifications; two thin processes usually proceed from near the hinge of the upper perforated valve, and form loops or simple apophyses; sometimes there is a median perpendicular lamella between them, and sometimes they develope other processes, and constitute a very complicated apparatus. Their nervous system is composed of several ganglia surrounding the œsophagus; their organs of taste are probably situated in the filaments of the mantle-margin; and those of touch most probably consist of the curious ciliated, twisted or spiral, tentacular arms. Their digestive organs do not differ materially from those of the Bivalves, the alimentary canal commencing in a simple oral aperture situated between the bases of the tentacular arms; in *Terebratula* it is tubular and curved for some distance, and then becomes dilated into a stomach, while in other genera, it makes several turns and continues throughout of the same calibre; there are no salivary glands, and the disintegrated liver pours its secretion directly into the digestive tube. The structure of the shell varies in different genera; in *Discina* it is almost entirely horny, in *Lingula* it is covered with an epidermis, which in *Terebratula* is entirely wanting. The shells of the *Terebratulidæ* are finely perforated, the tubular apertures being lined, in the living animal, with prolongations of the mantle. The Brachiopods are extremely numerous in fossil genera and species, and appear to have been among the forms of *Mollusca* earliest created. The recent genera are few, and live in all seas, usually at very considerable depths; the *Craniidæ* being sessile on stones and other sub-marine bodies; the *Terebratulæ* are also attached by means of their tendons; while the *Lingulæ* perforate the mud in more shallow situations.

V. CLASS.—BRACHIOPODS (Brachiopoda).

Animal furnished with a pair of ciliated oral arms, sometimes supported by a calcareous appendage; respiration performed by the vascular mantle; body covered with two shells. Attached to marine objects.

SUB-CLASS.—ANCYLOPOD-BRACHIOPODS (Ancylopoda).

Oral arms recurved and attached to fixed appendages on the disc of ventral valve; shell with numerous minute perforations.

I. ORDER.—ANCYLOBRACHIATE-BRACHIOPODS (Ancylobrachiata).

Oral arms affixed to calcareous plates, forming hoops attached to the hinge-margin of the ventral valve, and prominent in its cavity.

1. FAMILY.—*Lamp-Shells* (Terebratulidæ). Arms looped or contorted, fixed to an apophysary skeleton; shell regular, valves articulated, attached by a tendinous band which passes out of a hole in upper valve.

II. ORDER.—CRYPTOBRACHIATE-BRACHIOPODS (Cryptobrachiata).

Oral arms sunk into grooves in the convex centre of the inner surface of the ventral valve.

1. FAMILY.—*Thecidians* (Thecidæidæ). Arms contorted, fixed to margin of apophysary ribs and cardinal teeth; shell attached by apex of lower valve, which is produced.

II. *SUB-CLASS.*—HELICTOPOD-BRACHIOPODS (Helictopoda).

Oral arms regularly spirally twisted when at rest; shell not pierced with minute perforations.

I. ORDER.—SCLEROBRACHIATE-BRACHIOPDOS (Sclerobrachiata).

Oral arms supported by a shelly plate arising from the hinge-margin of ventral valve.

1. FAMILY.—*Beaked Lamp-Shells* (Lampasidæ). Arms spiral, supported only by short curved processes; shell not punctate, usually tetrahedral and sharply plaited. (*Rhynchonellidæ*, Auct.)

II. ORDER.—SARCICOBRACHIATE-BRACHIOPODS (Sarcicobrachiata).

Oral arms fleshy, without any shelly support; lower valve of shell simple, or with a slight median elevation.

1. FAMILY.—*Skull-Shells* (Craniidæ). Arms fleshy, spiral, attached to a process in centre of lower valve; upper valve limpet-like.
2. FAMILY.—*Disk-Shells* (Discinidæ). Arms ciliated, fixed to a central process of lower valve, which is perforated for the passage of a peduncle, or tendon of attachment; upper valve conical, simple.
3. FAMILY.—*Duck-billed Limpets* (Lingulidæ). Animal attached by a tendinous tube, which pro-

first shewed the true relations of the animal and its position among the tunicated Mollusks.

VI. CLASS.—TUNICARIES (Tunicata).

Animal acephalous, with a soft organized coriaceous or gelatinous test or shell provided with a branchial and an anal orifice; mantle forming an interior coat; gills attached wholly or partly to inner surface of mantle; mouth without labial tentacles; animals single or aggregate; fixed or free. Hermaphrodite.

1. FAMILY.—*Ascidians* (Ascidiidæ). Body sacciform, gelatinous or coriaceous, fixed at one end, free at the other, with two more or less prominent orifices; isolated or gregarious, not united by a common integument.

2. FAMILY.—*Social-Ascidians* (Clavellinidæ). Individuals each having its own heart, respiration, and system of nutrition; but fixed on peduncles that branch from a common creeping stem, and all connected by a circulation that extends throughout.

3 FAMILY. — *Compound - Ascidians* (Botryllidæ). Animals oval, adhering by their sides in a greater or less number so as to resemble a single complex animal; each individual with distinct branchial and anal orifices.

   1. *Polyclininæ.* Body divided into three distinct portions, or a thorax, a superior-abdomen, and a post-abdomen.

2. *Diademninæ.* Body distinctly divided into two parts, thorax and abdomen.
3. *Botryllinæ.* Body not divided into a distinct thorax and abdomen, the viscera being pushed forward on side of branchial cavity and forming, with thorax, an ovoid mass.

4. FAMILY.—*Pyrosomes* (Pyrosomatidæ). Common body semi-cartilaginous, floating, cylindrical, open at one of its extremities only; animals associated in a verticillate arrangement, having two orifices one at each extremity.

5. FAMILY.—*Salpians* (Salpidæ). Animal free, pelagian, in form of a more or less cylindrical tube open at one or both ends; test and mantle continuous at respiratory aperture, but elsewhere separated by a wide space; gill forming a hollow band across respiratory cavity; anal orifice ending close above and to right side of mouth.

6. FAMILY.—*Pelonaians* (Pelonaiidæ). Body cylindrical, with the branchial and anal orifices on the same plane on papillary eminences at one extremity; no rays or tentacles surrounding either of the 4-cleft orifices.

7. FAMILY.—*Appendicularians* (Appendiculariidæ). Body flask-shaped, with a lanceolate appendage; mouth at bottom of respiratory cavity; respiratory orifice at smaller extremity; gills represented by a ciliated band of mantle; anus on dorsal surface, in front of insertion of caudal appendage.

ANNULOSE ANIMALS.

The classes of the Annulose division of the Animal Kingdom, which is characterised chiefly by the segmented nature of the skin, the possession of jointed limbs, and a double knotted chord of nervous matter, vary greatly among themselves according to the modifications of their organs of locomotion, their breathing system, and their generative apparatus. Thus we find the Cirrhopods, covered with a testaceous envelope, fixed to one spot, and with their legs metamorphosed into breathing organs, living in the water; the Crustaceans, also aquatic animals, respiring by means of gills, and protected by a hard skin composed of carbonate of lime, and having never less than ten legs, but often furnished with many more variously modified; the Insects, the most highly organized and intelligent of all the Annulose classes, breathing the free air, having only six legs, usually provided with wings, and undergoing a regular metamorphosis; the Arachnidans, which have eight legs, respire free air, have no wings, and whose head, deprived of antennæ, is consolidated with the thorax forming a single piece; the Aiolopods, comprehending a a large portion of the Ametabolous Insects of Leach and Macleay, in which the number of legs is variable, where the head is provided with antennæ, and where the metamorphosis is irregular; and finally the worm-like Annelids, which gradually conduct us to the next and more apathetic Radiate division in which we see the locomotive organs begin to assume the form of jointless tubercles and even simple bristles, and where the ringed character of the skin becomes less and less obvious. As we have seen already in our sketch of the two former mighty zones of animal life, the Vertebrate and the Molluscous, so shall we be led by the study of the Annulose tribes to see many marvels of instinctive sagacity, of constructive power, and of admirable structure. We may be led to trace the changes from infancy to fixed old age of the molluscous, crab-like Barnacle; we may investigate the moulting of the Crustacean, read of the journeys of the Land-Crab, smile on beholding the monstrous claws of the Calling-Crab, or wonder at the ingenuity of the Soldier-Crabs; we may watch the ingenuity of the artful, spinning Spiders with their curious foot-brushes, egg-baskets, geometric webs, envenomed bite and cruel cunning; or admire with the Entomologist the plumed antennæ of the Gnats, the symmetric honey-cells of the ingenious Hive-bees, with their pollen-brushes, their pollen-baskets and their wax-pockets, or praise the colonising Ant and the paper-making Wasp,—examine the structure of the houses of the Caddis-Flies,—the conical den of the clever Ant-Lion,—the wondrous domes of the methodical White-Ants,—or deplore the ravages of the Plant-Lice, the Cockroaches, and the Locusts. Perhaps the Zoologist looking yet among the tribes with jointed skins, may pause to ponder on the gradual change exhibited by the Annelids from the vivacious *Nereis* with its powerful teeth-armed proboscis and numerous feet, down to the soft-bodied Leech and limbless Earth-worm. Thus we find crawling on the earth, or winging through the air, peopling the ocean, the river, and the swamp, or lending new beauty to the leaves, the flowers, and the trees, active, eager, Annulose creatures, bent upon rapine, eager for food, ardent in love, bustling, chasing, slaying, and caressing over the entire domain of Nature's Kingdom.

III.—SUB-KINGDOM OF ANNULOSE ANIMALS (*Annulosa*).

Nervous system composed of two parallel chords, united by a regular series of ganglia; body symmetrical, jointed, often with jointed appendages; respiratory organs distinct; jaws, when present, lateral, with lateral movements.

INSECTS.

The travelling naturalist will find himself surrounded by the wonders of the insect-world, whatever may be his destination. The singing of *Cicadæ* in the woods, the leaping of Grasshoppers in the prairies, the flitting lights of Fire-Flies at night, the glittering forms of Beetles in the sun, the nests of Wasps hanging on the trees, the galls of *Cynipidæ* on the leaves, the cocoons of Moths in crevices of bark, the flights of Locusts on the plains, the ravages of *Aphides*, the depredations of Ants, the attacks of Mosquitoes, and the swarms of Flies that make the air above him musical, will all force themselves upon his notice. Among the Beetles he will of necessity acquire many fine species, these insects being very numerous, more than eighty thousand species being already known. He will see the splendid *Buprestidæ* alighting on the leaves and trunks of trees in sunny spots of the woods, the Tiger-Beetles flying over sandy tracts, the Ground-Beetles running among the herbage, the Diving-Beetles in the ponds, the Carrion-Beetles preying on the carcases, the Dung-Beetles revelling in the excrement of various quadrupeds, the Fungus-Eaters in the rotting Toadstools and Agarics, and the Stag-Beetles and Darkling-Beetles hiding under bark, or among the tangled roots of old forest trees.

Among Orthopterous insects, tropical forms of large size and splendid colours will often arrest his attention, nor will he fail to marvel at the wondrous forms of the Walking-Stick and Leaf-Insects he may encounter on his path. Among this order he will also find the devastating Locusts, the lively Crickets, the pestiferous Cockroaches, and the pious Soothsayers, which raise their fore-feet as in the act of prayer.

The little Bee-Parasites (*Strepsiptera*) must be sought after by the intelligent traveller in the bodies of the Bees he may capture, on examining the abdomens of which he will see their small white heads protruding from between the segments. Of course among the Neuropterous insects the Dragon-Flies will be most eagerly pursued; they will be found especially numerous in marshy places, where their blue, green, and crimson bodies impart a brilliant aspect to the scenery. The White-Ants (*Termitidæ*), though not so beautiful, are also important objects of observation, from their being active agents in removing decomposing matter, on account of the prodigious damage they do among the habitations of man, and for the curious edifices they rear.

The Hymenopterous tribes need only be referred to as comprising the Bees, the Ants, the Wasps, and the Ichneumon-Flies, to remind our travelling inquirer of the curious nests of wax and paper they manufacture, and the stores of honey many of them gather for the use of man. Among the *Homoptera*, he will find in the course of his rambles the musical *Cicadæ*, the strangely-fashioned Lanthorn-Flies, the Cochineal insects, manufacturers of a valuable dye, the destructive *Aphides*, the curious Wax-Insects, the useful Lac-Insects, to whom we owe shell-lac, and the pernicious Scale-Insects so injurious to the agriculturist and the lover of flowers. Clinging to the leaves, upon the juices of which they feed, or preying on smaller and more defenceless insects, the various forms of *Hemiptera* will attract his notice; they are extremely numerous in the tropics, and exhibit not only wonderful forms but great and varied brilliancy of colour; when touched they emit a peculiar odour, and some inflict a painful sting.

The Caterpillars of the *Lepidoptera* will be observed eating the leaves of various plants, frequently of considerable size, and of the strangest forms; Chrysalids suspended by their tails, braced by silken bands, or encased in shrivelled leaves, will be seen hanging from the branches, or entombed among the crevices of the bark; and the perfect Butterflies will court his notice as they alight to suck the juices of the fruits and flowers, or as their splendid wings glance in the sunbeams among the forest glades. With the setting sun the Butterflies will give place to the noiseless Moths, some of which, as the *Saturnia Atlas*, are eight or nine inches across the wings, and all of which are worthy of capture. The two-winged Flies, or *Diptera*, he will see hovering over woody places during the heat of the day, or settling on the flowers in the sun; the Forest-Flies (*Tabanidæ*) will put his patience to the test, and in the swamps the Mosquitoes will sorely try his temper, which pernicious Gnat is the *Culex Mosquito* in the West-Indies, and the *Culex molestus* in the Brazilian forests.

I. CLASS.—INSECTS (Insecta).

Animal breathing by tracheæ; head furnished with antennæ; eyes compound; body in general winged, composed of a series of segments disposed in three portions, or head, thorax, and abdomen; legs six, jointed; sexes distinct. Undergoing a regular metamorphosis.

I. *SUB-CLASS.*—BITING-INSECTS (Mandibulata).

Mouth furnished with transverse jaws.

BEETLES.

Beetles are readily distinguished from the other insect tribes on account of their first pair of wings being changed into hard horny coverings, or *elytra*, which protect and conceal the hind wings when they are at rest. Except by the eye of the Naturalist these insects are seldom seen on the wing; in crossing sandy heaths near the sea, the beautiful Tiger-Beetles will, however, occasionally start up beneath the feet; in the woods the Springing-Beetles will be seen alighting on the leaves, and often in an evening stroll the poet's well-known lines,—

> "Save where the Beetle wheels his drony flight,"

is brought vividly before the mind by the steady course of the Dor- and the Stag-Beetle. The extreme diversity of form often assumed by these case-winged insects may be well shewn by contrasting the curious *Mormolyce* of Java, with its flattened leaf-like body and elongated head, with the leaping *Mordella* in which the head is entirely concealed, and the elytra pointed and narrow; or by comparing the diving *Dyticus*, with its compact and hornless body and oar-shaped feet, with the long horned South American *Acrocinus* or long legged Harlequin-Beetle; or again, the Elephant *Balaninus*, with its arched back and slender proboscis, with the depressed form and powerful mandibles of the *Cicindelidæ.* In like manner what shall we say to the remarkable Kangaroo-Beetle, with its enormous thighs, when contrasted with the short-legged *Byr-*

rhus, or the Helmet-Beetle. In confirmation of their beauty the advocate of the beetles may point to our native Rose-Chaffer, and bid us gaze on the splendour of the Sun-Beetles and the Diamond-Beetles.

The utility of these despised creatures to lordly man is by no means so great as the loss they occasion him by the depredations of their larvæ; we may, however, refer to the useful labours of the Blister-Beetles, the Carrion-Beetles, the Dung-Beetles, and the Rove-Beetles, to enlist our sympathy in their behalf; while to prove the importance of becoming acquainted with their habits we may allude to the ravages of the Turnip-Fly, the Chaffer's-Grubs, the Corn-Weevils, the Skin-Beetles, the Book-Worms, and the Wood-Borers. Beetles, like Butterflies, pass through several stages in their lives, being hatched from eggs, then existing as greedy grubs (often mischievous withal), next becoming inert chrysalids, and finally assuming their nuptial attire, in which they prosecute their loves and are often seen no more. The instinctive sagacity of our little favourites is also worthy of our notice, whether we contemplate the Sexton-Beetles burying the bodies of the dead as nutriment for their own young progeny, the Bombadier-Beetles repelling their enemies by repeated discharges of an acrid vapour, a kind of small artillery, or the cunning Mimic and Pill-Beetles, *Hister* and *Byrrhus*, feigning death when they fall into the hands of their enemies, and thus escaping destruction.

I. ORDER.—Beetles (Coleoptera).

Wings four, the anterior one (or elytra) hard, horny, or leathery, covering the hind wings and abdomen in repose, united down the back by a straight suture; hind wings membranous, folded when at rest; mouth with transversely moveable jaws.

I. LEGION.—Adephagous-Beetles (Adephaga).

Outer lobe of maxillæ distinct, jointed, palpiform; lower jaws armed with spines and ending in an acute hook; antennæ long and slender; anterior tarsi generally dilated in the males. Predaceous, feeding on other insects.

I. *SUB-ORDER.*—Predaceous Ground-Beetles (Geodephaga).

Legs long, formed for running; the four hinder placed at equal distances apart; body oblong; antennæ filiform or setaceous; eyes prominent. Terrestrial,

1. Family.—*Tiger-Beetles* (Cicindelidæ). Maxillæ with a moveable claw at tip; mandibles strong, acute, armed with teeth; antennæ filiform; labial palpi hairy, 3-jointed, with a moveable base; head large; eyes prominent; legs long, slender; fore-tibiæ not notched on inner side. Carnivorous; fly in the sunshine; run with great agility.
2. Family.—*Bombardier-Beetles* (Brachinidæ). Maxillæ with a fixed claw at tip; labrum linear,

notched or trilobate; labium exserted; labial palpi 4-jointed, basal joint fixed; antennæ filiform; elytra truncate behind, shorter than abdomen; legs moderate; fore-tibiæ with a notch on inner side near the tip; anterior tarsi rarely dilated in the males; head and thorax narrower than abdomen. Emit a pungent vapour, accompanied by an explosion.

3. FAMILY.—*Burrowing Ground-Beetles* (Scaritidæ). Maxillæ with a fixed claw at tip; labrum short, sometimes trilobate; labium short; labial palpi 4-jointed, basal joint fixed; elytra entire behind; abdomen pedunculated; fore-legs expanded and palmate externally; anterior tarsi simple in both sexes; antennæ moniliform; nocturnal, living in holes near the sea shore.

4. FAMILY.—*True Ground-Beetles* (Carabidæ). Maxillæ with a fixed claw at tip; labrum lobate; labium usually toothed; labial palpi 4-jointed, basal joint fixed; mentum large, produced in the centre; elytra entire, not truncate; fore-tibiæ slender, not notched within; fore-tarsi greatly dilated in the males. Run fast; when irritated eject an acrid fluid from abdomen.

5. FAMILY.—*False Ground-Beetles* (Harpalidæ). Maxillæ with a fixed claw at tip; labrum usually quadrate; labium not toothed, furnished with a process on each side; labial palpi 4-jointed, basal joint fixed; mandibles

slightly toothed within; mentum deeply notched; body elongate, neck rarely distinct; elytra entire or slightly notched behind; anterior tibiæ notched on inner side; fore-tarsi more or less dilated in the males.

1. *Feroniinæ.*—Two anterior tarsi alone dilated in the males; four hind tarsi simple; central tooth of mentum notched at tip.
2. *Harpalinæ.*—Four anterior tarsi dilated in the males; mentum tooth acute, never notched.
3. *Chlæniinæ.*—Front tarsi of males with two, three, or four of the basal joints square or cordate.

The species of this family are exceedingly numerous.

6. FAMILY.—*Subaquatic-Beetles* (Bembidiidæ). Maxillæ with a fixed claw at tip; labrum transverse; labium quadrate; maxillary and labial palpi with the last joint minute; mentum notched; antennæ filiform; elytra entire; fore-tibiæ not palmate, their inner edge notched; anterior tarsi with one or more dilated joints in the males. Live on the margins of streams.

7. FAMILY.—*Marsh-Beetles* (Elaphridæ). Maxillæ with a fixed claw at tip; labrum entire; mandibles simple; labial palpi 4-jointed, apical joint tumid, basal, fixed; mentum notched, with a bifid central tooth; elytra entire; anterior tibiæ not palmate, without a notch on the side, slightly notched at tip; fore-tarsi

not dilated in the males. Living in marshy situations.

II. *SUB-ORDER.*—PREDACEOUS WATER-BEETLES (Hydradephaga).

Legs short, formed for swimming; hinder pair remote from the others and horizontal; hind-tibiæ and tarsi generally compressed and fringed with hair; body ovate; antennæ setaceous; eyes not prominent. Aquatic.

8. FAMILY.—*Diving-Beetles* (Dyticidæ). Antennæ long, setaceous; legs unequal, hind pair longest, deeply fringed; tarsi broad, flat, fringed, ending in a point; males with the fore tarsi dilated, females often with elytra sulcate. Swim and dive with agility, inhabit ponds, often fly by night.

9. FAMILY.—*Whirlwigs* (Gyrinidæ). Antennæ short, clavate, rigid, second joint with a lobate appendage; eyes divided; thorax transverse, waved before and behind; legs unequal, the two front very long, ambulatory; the four hind very short, compressed, formed for swimming; with a metallic lustre. Usually swim on the surface of the water.

II. LEGION.—RYPOPHAGOUS-BEETLES (Rypophaga).

Mouth with four palpi, the inner maxillary represented by outer lobe of maxillæ, which is dilated or jointed but not palpiform; antennæ gradually or abruptly clavate; males with basal joints of tarsi more or less dilated. Feeding on animal and vegetable substances in a state of decay.

III. *SUB-ORDER.*—WATER-LOVING BEETLES (Philhydridæ).

Mandibles small, rarely exserted; maxillary palpi usually 4-jointed; body short, convex; elytra covering abdomen; hind-legs usually formed for swimming, sometimes for walking; fore-tibiæ often spinose. Aquatic or sub-aquatic.

10. FAMILY.—*Mud-burrowing Beetles* (Heteroceridæ). Antennæ 11-jointed, two basal joints large, the others forming an obscurely serrated mass thickened towards the tip; head elongate, deeply inserted into thorax; thorax transverse; body flattish; tibiæ compressed, spinose. Form burrows in muddy banks of ponds.

11. FAMILY—*Pond-Beetles* (Parnidæ). Antennæ 9-jointed, the second with a lobate appendage, the rest forming a clavate serrated mass; body sub-cylindric, convex; head deeply inserted into thorax; thorax quadrate, narrowed in front; tibiæ cylindric, simple; tarsi filiform, long, 5-jointed. Burrow among the roots of aquatic plants.

12. FAMILY.—*Stream-Beetles* (Limniidæ). Antennæ 9—13-jointed, somewhat filiform, terminal joints largest, forming a club; body ovate or sub-globose, convex; head inflexed, deeply inserted into thorax; thorax sub-qua-

drate, margined; legs long, tibiæ slender, not spinose; tarsi 5-jointed. Live under stones in running streams.

13. Family.—*Herbivorous Water-Beetles* (Helophoridæ). Antennæ 9-jointed, perfoliate, clavate; club sub-serrated; mandibles not toothed at tip; maxillary palpi very long; body oblong, flattish; thorax sub-quadrate; tibiæ slightly spinous; tarsi 5-jointed, filiform, not ciliated, basal joint minute. Inhabit ponds and ditches; herbivorous in the perfect state.

14. Family.—*Water-Beetles* (Hydrophilidæ). Antennæ 6—9-jointed, perfoliate, clavate, club distinctly cleft, mandibles bidendate at tip; maxillary palpi very long, filiform; body oval or globose; thorax short, transverse; tibiæ slightly spinose; tarsi 5-jointed, filiform, hind pair often ciliated. Frequent the water, fly abroad in the evening.

15. Family.—*Excrement-Beetles* (Sphæridiidæ). Antennæ short, 9-jointed, basal joint very long, four next short, the rest forming a compressed perfoliate club; maxillary palpi as long as antennæ, second joint thickened, head round in front; thorax transverse; body more or less hemispheric; tibiæ compressed, spinose; tarsi filiform; claws two, unequal. Living in the excrement of various animals.

16. Family.—*Armadillo - Beetles* (Agathidiidæ). Antennæ 11-jointed, rather long, slender at

base, ending in a club; palpi short; head small, ovate; thorax more or less gibbous; body convex, orbicular or globose; tibiæ often spinose and compressed; tarsi of four or five joints. Counterfeit death by rolling themselves into a ball. (*Anisotomidæ*, Stephens.)

IV. *SUB-ORDER.*—CARRION-BEETLES (Necrophaga).

Mandibles generally elongate, exserted; maxillary palpi with the basal joint minute or wanting; maxillæ with a double membranaceous process, the outer lobe often slender, rarely jointed; body more or less elongate, depressed; elytra frequently abbreviated; legs all formed for walking; anterior tibiæ simple. Feed on decaying animal and vegetable matter.

17. FAMILY.—*Scavenger-Beetles* (Scaphidiidæ). Antennæ more or less clavate; club 5-jointed, the second joint often minute; maxillary palpi generally exserted; mandibles mostly bidentate at tip; head inserted up to eyes in thorax; thorax convex; legs long. Feed on decaying fungi, rotten bones. Frequent dunghills.

18. FAMILY.—*True Carrion-Beetles* (Silphidæ). Antennæ clavate; club usually 4 or 5-jointed, maxillary palpi filiform, the last joint cylindric; mandibles entire at tip; head inflexed, contracted behind into a neck; thorax large, shield-shaped; elytra simple, outer margin

generally with a groove; body depressed; legs rather short. Found in carrion and the carcasses of animals.

19. Family.—*Bone-Beetles* (Nitidulidæ). Antennæ abruptly clavate; club 3 or 4-jointed; palpi filiform, short; mandibles elongate, notched at tip; head inserted up to eyes in thorax; thorax broad; body flat, wide; legs short. Feed on bones and other animal remains.

20. Family.—*Hairy Fungus-Beetles* (Mycetophagidæ). Antennæ gradually clavate; club from two to four joints; palpi rather long; maxillæ bilobed; mandibles short, bifid at tip; labrum transverse; head somewhat inserted into thorax; body rather wide, hairy or pubescent. Living principally on decaying fungi.

21. Family.—*Smooth Fungus-Beetles* (Erotylidæ). Antennæ ending in a large 3-jointed club; palpi with apical joint large; maxillæ compressed, subulate; mandibles short, dentate at tip; head small; body oval or hemispheric, smooth, polished. Feeding chiefly on putrescent fungi.

22. Family.—*Elongate Bark-Beetles* (Engidæ). Antennæ short, more or less distinctly clavate; club 2—5-jointed; palpi rathers hort; maxillæ mostly one-lobed; mandibles bifid at tip; labrum transverse; head deeply inserted in thorax; body elongate, glabrous. Usually found under bark of trees.

23. FAMILY.—*Flat Bark-Beetles* (Cucujidæ). Antennæ rather long, moniliform, slightly thickened at tip or distinctly clavate; palpi short, filiform; mandibles large, exserted, bifid at tip; labrum rounded; head large, exserted; body oblong, flat. Chiefly found beneath the bark of trees.

24. FAMILY.—*Skin-Beetles* (Dermestidæ). Antennæ short, rather abruptly clavate; club 3—4-jointed; palpi very short; mandibles short, thick, toothed at tip; labrum short, membranous at tip; body convex, oval, rounded at each end, clothed with scales or pile; legs contractile. Counterfeit death. Found in old skins, furs, and dried carcasses.

25. FAMILY.—*Nocturnal Wood-Beetles* (Paussidæ). Antennæ very large, of two or more joints; irregular; palpi much developed, unequal; head small, generally narrowed behind into a neck; body oblong, quadrate, depressed; elytra broader than thorax; legs short, strong, compressed. Nocturnal, wood-eating.

V. *SUB-ORDER.*—ROVE-BEETLES (Brachelytra).

Mandibles strong, seldom exserted; palpi generally filiform or subulate, rarely clavate; maxillary palpi 4-jointed, labial 3-jointed, their last joint sometimes minute or obsolete; maxillæ with the tip often bifid; outer lobe palpiform; body very long, narrow, with two vesicles at tip; elytra considerably abbreviated, rarely covering half the abdomen;

legs formed for walking, anterior pair with elongate coxæ; antennæ usually moniliform, slightly thickened at tip. Voracious, living on decaying animal and vegetable matter.

26. FAMILY. — *True Rove-Beetles* (Staphylinidæ). Antennæ short, stout, inserted between the eyes; maxillary palpi short, filiform; labrum mostly with a deep notch in front; head exserted, neck distinct; thorax quadrate or sub-ovate; body elongate; elytra moderate; tibiæ spinose. Usually found under dead leaves, stones, or dung.

27. FAMILY. — *Large-eyed Rove-Beetles* (Stenidæ). Antennæ sub-filiform; mandibles long, acute, sharply toothed internally; maxillary palpi long, clavate, apical joint minute; labrum entire; eyes usually very large; head large, exserted, with a short neck; thorax rounded, heart-shaped, or globose; tibiæ simple. Inhabit damp situations; run with great agility.

28. FAMILY.—*Burrowing Rove-Beetles* (Oxytelidæ). Antennæ thickened towards apex; maxillary palpi short; apical joint distinct; labrum entire; head exserted; neck distinct; thorax mostly heart-shaped; body linear; anterior tibiæ spinose or toothed on outer margin. Burrow underground, under dung, or form galleries in rotten bark.

29. FAMILY.—*Broad-bodied Rove-Beetles* (Omaliidæ). Antennæ rather short, thickened at tip, rarely filiform; maxillary palpi short, apical joint

minute; labrum transverse, entire; head exserted; thorax usually convex, wide behind; body broad, flattened; elytra rather long; tibiæ simple. Found in decaying vegetables, dung, and moss.

30. Family.—*Small-headed Rove-Beetles* (Tachyporidæ). Antennæ gradually thickened to apex; last joint sometimes very large; maxillary palpi generally acute; eyes small; head usually inserted deeply into thorax; thorax broadest behind; elytra short; tibiæ sometimes spinose. Frequent putrescent fungi and other decaying vegetable substances.

31. Family.—*Moss-loving Rove-Beetles* (Pselaphidæ). Antennæ clavate; maxillary palpi generally very long, clavate; labrum minute; eyes prominent; head exserted, narrowed behind eyes; body short, robust; elytra nearly half the length of abdomen, broader than thorax, folded at base; tarsi 3-jointed, with a single claw. Generally found during the winter and spring in moss.

III. LEGION.—Varicorn-Beetles (Varicornes).

Palpi four, two labial and two maxillary, the inner maxillary pair wanting; head not produced into a rostrum in front; antennæ various; tarsi usually 5-jointed.

VI. *SUB-ORDER.*—Clavicorn-Beetles (Helocera).

Antennæ more or less clavate, tip sometimes rather abruptly slender, joints unequal; basal occasionally half the entire length; thorax often with a groove beneath to receive the antennæ; body more or less globose and convex, or quadrate and depressed; sternum often produced in front, concealing the mouth beneath; legs more or less compressed, capable of being closely applied to body in excavations for receiving them.

32. FAMILY.—*Pill-Beetles* (Byrrhidæ). Antennæ not elbowed, mostly placed in repose in a groove beneath sides of thorax; mandibles not exposed; body short, oval, very convex, generally pilose; legs contractile. Found in sand-pits and on foot-paths. Feign death, folding up the legs and antennæ.

33. FAMILY.—*Mimic-Beetles* (Histeridæ). Antennæ elbowed, basal joint long, the others placed angularly at its tip; mandibles rather long, exserted; body hard, polished, square or oblong, quadrate; elytra generally short and truncate; legs dentate, the hinder inserted, widely apart. Counterfeit death. Found in dung or beneath bark of trees.

VII. *SUB-ORDER.*—LAMELLICORN-BEETLES (Lamellicornes).

Antennæ clavate, the club composed of three or more lamellæ or pectinations, the apical joints either lamellated or the basal joint cup-like, receiving the other joints; legs robust, the fore-tibiæ generally dilated and toothed.

34. FAMILY.—*Stag-Beetles* (Lucanidæ). Antennæ strongly elbowed, with the club pectinated; mandibles (especially in the male) very large; body oblong, oval, depressed; elytra entirely covering the abdomen; legs elongate, claws large, with a bifid process between them.

35. FAMILY.—*Sacred-Beetles* (Scarabæidæ). Antennæ 8 or 9-jointed; labrum, mandibles, and maxillæ membranaceous; club of antennæ large, 3-leaved; clypeus large, advanced, notched in front; body broad, depressed; scutellum concealed; legs stout, the hinder remote; tibiæ broad, dentate; claws small. Terrestrial. Living on excrementitious matter.

36. FAMILY.—*Shard-Beetles* (Geotrupidæ). Antennæ 10 or 11-jointed; mandibles porrect, horny, exposed; club of antennæ large, globose; body short, thick, convex, elytra entirely covering the abdomen; legs very stout; tibiæ broad, spinose at tip, dentate; tarsi long and slender. Terrestrial. Living on excrementitious matter.

37. FAMILY.—*Sand-Beetles* (Trogidæ). Mandibles horny, stout, exposed, acute at tip; club of antennæ transverse; body ovate, gibbose; elytra inflexed at the sides; legs short, stout; tibiæ compressed. Terrestrial. Living in the sand on excrementitious matter.

38. FAMILY.—*Dung-Beetles* (Aphodiidæ). Antennæ 8 or 9-jointed; labrum, mandibles, and maxillæ membranous, concealed; club of antennæ

sub-ovate; body oblong; abdomen entirely concealed by the elytra; legs short, equidistant; thighs with a row of hairs within; tibiæ broad, dentate. Terrestrial. Living on excrementitious matter.

39. FAMILY.—*Rhinoceros-Beetles* (Dynastidæ). Antennæ 10 or 11-jointed; mandibles horny, convex, obtuse at tip, exposed; club of antennæ short, ovate; clypeus small, triangular, usually horned; body large, the males often with horns and tubercles on thorax, legs stout, anterior tibiæ strongly dentate; tarsi long. Arboreal. Living on decayed trees.

40. FAMILY.—*Kangaroo-Beetles* (Rutelidæ). Antennæ 10 or 11-jointed; mandibles horny, exserted, with a notch on inner margin near tip; body ovate, depressed; scutellum distinct; elytra shorter than abdomen; thorax and clypeus unarmed; legs robust, hinder thighs sometimes greatly thickened; claws of tarsi usually unequal in size. Arboreal. Living on the decomposed matter of decaying trees.

41. FAMILY.—*True-Chaffers* (Melolonthidæ). Antennæ 10 or 11-jointed; mandibles horny, stout, concealed; labium concealed by mentum; club of antennæ foliated; labrum bilobed; body ovate, sub-convex, shorter than abdomen; legs rather long and slender; tibiæ not dilated; claws bifid or dentate. Arboreal. Eating the leaves of trees.

42. FAMILY.—*False-Chaffers* (Anoplognathidæ). Antennæ 10 or 11-jointed; mandibles large, horny, obtuse at tip; labium concealed by mentum; clypeus dilated in front, entirely concealing the mandibles; body ovate, convex, or sub-quadrate; mesosternum often produced into a spine in front; legs robust, the hind pair often greatly thickened. Arboreal. Eating the leaves of trees.

43. FAMILY.—*Flower-Beetles* (Glaphyridæ). Antennæ 10 or 11-jointed; mandibles horny, concealed, dilated; labium produced; maxillæ with a coriaceous pilose lobe forming a small brush; body ovate, depressed, squamose or pilose; elytra shorter than abdomen; legs long, hinder thighs sometimes thickened; tarsi spinulose. Floral. Living on the juices of flowers.

44. FAMILY.—*Sun-Beetles* (Cetoniidæ). Antennæ 10 or 11-jointed; mandibles membranous, compressed, slender, lanceolate; maxillæ with the inner margin ciliated; labium concealed by mentum; antennæ glabrous; body oblong-ovate, depressed; scutellum distinct; mesosternum often produced into a spine in front; legs slender, claws simple, acute. Floral. Living on the juices of flowers.

VIII. *SUB-ORDER.*—HARD-SKINNED SERRICORN-BEETLES (Sternoxi).

Antennæ filiform, pectinate or serrated; sternum armed with a spine, the tip received into a cavity of breast; body hard, elliptic, conic, or trigonate, sometimes elongate; head short, deeply inserted in thorax; thorax with hind edges acute; legs short, capable of being closely applied to body. Feed on wood, sap leaves, or flowers.

45. FAMILY.—*Gold-Beaters* (Buprestidæ). Antennæ short, serrated; mandibles entire; palpi mostly filiform; thorax sometimes lobate behind, the hind angles slightly produced, never acute; body hard, oblong-ovate or depressed; elytra frequently narrowed at tip; tarsi short, third and fourth joints generally heart-shaped. Reside in thick woods and forests; fly actively in the sunshine; colours bright, often metallic.

46. FAMILY.—*Oak-Beetles* (Eucnemidæ). Antennæ pectinated or serrated, lodged in repose in grooves on under side of thorax; mandibles ending in a simple tooth; palpi with apical joint large; body oblong-cylindric, or ovoid; elytra rounded at tip; tarsi compressed or dilated; claws sometimes denticulated. Living in decayed oak-trees; flying in the hot sunshine; unable to leap.

47. FAMILY.—*Springing-Beetles* (Elateridæ). Antennæ short, more or less serrated; mandibles notched at tip; palpi ending in a large triangular joint; thorax with hind angles produced into an acute spine, sides grooved for reception of antennæ; prosternum produced be-

hind into a compressed spine which fits into a groove in front of mesothorax; tarsi rather long and slender. Possess the power of springing when laid on their backs; creep slowly; fall to the ground on approach of danger; colours dingy.

IX. *SUB-ORDER*.—SOFT-SKINNED SERRICORN-BEETLES (Malacodermata).

Antennæ usually elongate, more or less serrated or pectinate, the last three joints often produced or clavate; head deflexed, usually deeply inserted into thorax; thorax semicircular or cylindric; body soft, depressed, usually elongate or cylindrical; legs rather long.

48. FAMILY. — *Flabellicorn-Beetles* (Cebrionidæ). Antennæ pectinate or flabellate in males; palpi filiform; labium short; mandibles strong, curved, entire at tip, exposed; head small, inclined; body hard, convex, deflexed in front; legs not contractile, nor formed for leaping. Found in forests on low plants, feeding on leaves and stems; fly and walk slowly.

49. FAMILY.—*Reed-Beetles* (Cyphonidæ). Antennæ filiform, sometimes subserrated; maxillary palpi filiform, labial furcate; mandibles concealed; body soft, hemispheric, ovate or depressed; elytra flexible; head very small. Colours dull; found among reeds and plants in damp situations; fly and run with agility.

50. **Family.**—*Glow-worms* (Lampyridæ). Antennæ close together at base, filiform, serrated or pectinate; maxillary palpi slightly thickened at tip, much longer than labial; mandibles acute; head small, concealed beneath front of thorax; thorax semicircular or quadrate, forming a hood over head; elytra wanting in females of some species. Feign death; both sexes often emit a bright interrupted light, whence they are called "Fire-flies."

51. **Family.** — *Sailor-Beetles* (Telephoridæ). Antennæ rather remote at base, elongate, setaceous, rarely serrated; maxillary palpi with terminal joint ovate or hatchet-shaped; head exserted; body very soft; elytra long; penultimate joint of tarsi bifid. Predacious; found upon Umbelliferous flowers and Whitethorns.

52. **Family.**—*Insectivorous Flower-Beetles* (Melyridæ). Antennæ short, setaceous, sometimes serrated; palpi nearly equal, sub-filiform; mandibles elongate; head small, deeply inserted in thorax; thorax wider than head; body rather firm, elongate; tarsal joints all simple. Found on flowers; voracious, preying on other insects.

53. **Family.**—*Cuckoo-Beetles* (Cleridæ). Antennæ with the three or four terminal joints thickened; head inflexed, retractile within thorax to the eyes; eyes lunate; body elongate, rather soft, often cylindric; penultimate joint

of tarsi bilobed. Variegated in colour; deposit their eggs frequently in nests of bees and wasps.

54. FAMILY.—*Deathwatches* (Ptinidæ). Antennæ filiform, elongate, occasionally serrate or pectinated, or rather short, thick at apex with the last three joints suddenly elongated; mandibles and palpi short; head rounded, deeply inserted in thorax; thorax generally produced in front; tarsal joints simple. Feign death; slow-moving; found in old furniture, rotten palings, and stumps of trees, which they perforate in every direction; produce a ticking noise by striking the wood with their jaws.

55. FAMILY.—*True Wood-boring Beetles* (Lymexylonidæ). Antennæ short, fusiform, somewhat serrated; maxillary palpi of male with branched appendages, labial simple; neck narrow, distinct; mandibles short, stout; body linear; elytra gaping at tip; tarsal joints simple. Wood-boring, causing much damage in dockyards to timber.

56. FAMILY.—*Hooded Wood-boring Beetles* (Bostrichidæ). Antennæ clavate, basal joint robust; club solid or perfoliate, intermediate joints small; palpi short; head globose, deeply inserted in thorax; thorax obliquely truncate in front, forming a hood over the head, often roughened in front; body cylindric, tarsal joints simple. Found on trunks of old trees; commit depredations on timber.

IV. LEGION.—HETEROMEROUS-BEETLES (Heteromera).

Palpi four, two labial and two maxillary; labrum distinct; mandibles horny, inner edge with one or two teeth and furnished with a fleshy lobe; mentum distinct, labium leathery, pilose; antennæ various, never laminated or pectinate; legs various; tarsi heteromerous, or with the four anterior 5-jointed, the two posterior 4-jointed.

X. *SUB-ORDER.*—DARKLING-BEETLES (Melasomata).

Antennæ moniliform; maxillæ with an internal tooth; head not narrowed behind into a neck, apterous. Colours usually black or dingy.

57. FAMILY. — *Meal-Beetles* (Tenebrionidæ). Antennæ generally moniliform; palpi thickened at tip, apical joint mostly hatchet-shaped; head inserted up to eyes in thorax; thorax quadrate; body oblong flattish; claws simple. Feed upon wheat and flour; frequent corn-mills and bake-houses.

58. FAMILY.—*Sexton-Beetles* (Blapsidæ). Antennæ nearly filiform; palpi with terminal joint large, dilated, triangular; head inserted; thorax sub-quadrate; elytra soldered together; wings none; body elongate; claws simple. Found in churchyards and damp obscure situations.

59. FAMILY.—*Burrowing Shore-Beetles* (Pimeliidæ). Palpi filiform; mandibles bifid at tip; maxillæ concealed by mentum; labium slightly produced; elytra soldered together; wings

rudimentary or obsolete. Sluggish, living in sandy situations, or burrowing in the sea shores

XI. *SUB-ORDER.*—TAXICORN-BEETLES (Taxicornes).

Antennæ perfoliated; maxillæ unarmed; head not narrowed behind into a neck; elytra hard; tarsal claws simple.

60. FAMILY.—*Shield-Beetles* (Cossyphidæ). Antennæ ending in a 4 or 5-jointed club; body narrow, margins of thorax and elytra extended into a flattened shield all round the body. Colours dull; live under bark.

61. FAMILY.—*Fungivorous-Beetles* (Diaperidæ). Antennæ short, moniliform or pectinated; palpi nearly filiform, rarely enlarged at tip; head inserted; thorax quadrate, trapeziform, or somewhat cylindric; body rounded or quadrate, convex. Found in *Boleti* and *Fungi.*

XII. *SUB-ORDER.*—STENELYTROUS-BEETLES (Stenelytra).

Antennæ simple; maxillæ unarmed; head not narrowed behind into a neck; elytra hard; winged; tarsal claws simple.

62. FAMILY.—*Garden-Beetles* (Helopidæ). Antennæ filiform, base concealed; palpi with terminal joint large, hatchet-shaped; head inserted; thorax transverse; elytra not soldered together; wings rudimentary or short; claws simple. Often found in gardens upon flowers.

63. FAMILY.—*Narrow-winged Flower-Beetles* (Cistelidæ). Antennæ filiform, sometimes pectinate or serrated, base not concealed; palpi filiform or with the apical joint hatchet-shaped; head inserted; thorax transverse; elytra free; wings ample; body elongate, softish; claws denticulated. Chiefly found upon flowers and in hedges.

64. FAMILY.—*Leaping Bark-Beetles* (Melandryidæ). Antennæ shortish, filiform; maxillary palpi with the last three joints large, often deflexed; eyes occasionally notched; head inserted, sometimes inflexed; thorax widest behind; body elongate, sub-cylindric or flattish; hind legs often long, compressed, formed for leaping. Chiefly reside beneath the bark of trees.

65. FAMILY.—*Thick-legged Flower-Beetles* (Œdemeridæ). Antennæ rather long, filiform; head deeply inserted in thorax, more or less elongate in front; thorax somewhat quadrate; body elongate, flattish; elytra sometimes narrowed at tip; hind thighs of males often greatly thickened; claws simple. Of lively colours; frequent flowers, fly with agility, but do not leap.

XIII. *SUB-ORDER.*—TRACHELIDAN-BEETLES (Trachelides).

Head narrowed behind into a neck; body soft; tarsal claws often bifid.

66. FAMILY.—*Mimic Flower-Beetles* (Lagriidæ). Antennæ filiform, inserted in a notch of the eyes; palpi thickened at tip; mandibles thick, short; head inserted; thorax narrower than elytra; body elongate; elytra, free, ample, soft, flexible; femora oval, clavate; penultimate tarsal joint bilobed, claws simple. Found on plants in woods and hedges. Feign death when alarmed.

67. FAMILY.—*Blistering-Beetles* (Cantharididæ). Antennæ various; palpi mostly filiform; head dilated behind eyes, united to thorax by a distinct neck; thorax somewhat quadrate; elytra flexible, deflexed at sides, often shortened or devaricating; claws bifid. Variegated in colour; feign death. Many possess powerful blistering properties.

68. FAMILY.—*Soldier-Beetles* (Pyrochroidæ). Antennæ filiform, pectinate or serrated; maxillary palpi with terminal joint somewhat hatchet-shaped; head exserted, with a distinct neck; thorax small, somewhat orbicular; elytra ample, flattish; penultimate joint of tarsi bifid; claws simple. Colours often red. Frequent leaves and flowers.

69. FAMILY.—*Parasitic Flower-Beetles* (Mordellidæ). Antennæ short, often flabellate or serrated; head inflexed, closely applied to thorax; thorax trapeziform; body elevated, arched; elytra narrowed at tip; abdomen conic, sometimes with an anal style; legs

dissimilar, the hinder often compressed, with long tibial spurs; tarsal claws bifid. Frequent flowers, fly with rapidity, leap well; often parasitic on other insects.

70. Family. — *Unicorn-Beetles* (Notoxidæ). Antennæ simple, rarely filiform; maxillary palpi with terminal joint hatchet-shaped; head subcordate, with a distinct neck; thorax narrowed behind, sometimes armed in front; elytra rigid, as long as abdomen; legs rather short, claws simple. Found about roots of grass in sandy situations.

71. Family.—*Parasitic Wood-Beetles* (Horiidæ). Antennæ rather short; palpi filiform, labial as long as maxillary; jaws large, porrected, ending in an acute point; head large, dilated behind eyes; thorax sub-quadrate; elytra flexible; tarsal claws denticulated, furnished beneath with a long slender filament. Parasitic in the nests of wood-boring Bees.

72. Family.—*Social Grass-Beetles* (Scydmænidæ). Antennæ rather long, distinctly clavate; palpi with third joint large, pear-shaped, terminal, minute; head slightly narrowed behind; thorax sub-globose, broader than head; elytra ample, convex, entire; legs slender, thighs incrassated; tarsi 5-jointed. Live among grass and moss, in society.

73. Family. — *False Snout-Beetles* (Salpingidæ). Head deeply inserted, produced in front into a short flattened snout; antennæ in-

serted at the base in front of eyes; palpi filiform, short; maxillæ bilobed; thorax more or less heart-shaped; body ovate or oblong, flattish; legs slender; penultimate joint of tarsi bilobed. Often brightly coloured; found in flowers or beneath the bark of trees.

V. LEGION.—PSEUDOTETRAMEROUS-BEETLES (Pseudotetramera).

Palpi four, two labial and two maxillary; head produced in front into a rostrum with the mouth at its apex, with the antennæ 9–10-jointed, more or less clavate, or head not rostrate, with the antennæ 11 or 12-jointed, filiform or setaceous, occasionally serrated; labium more or less heart-shaped; tarsi 5-jointed, the fourth joint very minute and concealed by the third.

XIV. *SUB-ORDER.*—SNOUT-BEETLES (Rhynchophora).

Head produced in front into a rostrum with the mouth at the apex; palpi minute; labrum wanting or obsolete; mandibles generally small, stout; antennæ inserted on rostrum, mostly clavate, basal joint usually elongate; funiculus (joint between basal one and club) slender; body short, firm, hard; abdomen mostly robust. Subsisting upon plants.

I. TRIBE.—STRAIGHT-HORNED SNOUT-BEETLES (Orthocerata).

Antennæ not elbowed, basal joint not much elongated; rostrum without lateral canal for reception of basal joint of antennæ.

74. FAMILY.—*Grain-eating Snout-Beetles* (Bruchidæ). Antennæ filiform or slightly thickened ate tip, serrated or pectinate; eyes emarginate; rostrum broad, deflexed; elytra not entirely covering abdomen; hind-legs often very large. Feeding on grain, seeds, and nuts.

75. FAMILY. — *Club-horned Snout-Beetles* (Anthribidæ). Antennæ distinctly and suddenly clavate; eyes entire; rostrum short, broad, deflexed; elytra truncate; mandibles robust, toothed; labium and labial palpi arising from a large, lunate, horny piece. Usually found among old wood, or on the trunks of trees.

76. FAMILY. — *Leaf-rolling Snout-Beetles* (Attelabidæ). Antennæ straight, inserted upon rostrum, the terminal joints forming a club; labrum obsolete; palpi conical; head produced into a cylindrical bent rostrum without lateral grooves; body ovate, narrowed in front; tarsi with third joint bifid. Females roll up portions of leaves in which the eggs are deposited.

77. FAMILY.—*Elongate Snout-Beetles* (Brenthidæ). Antennæ straight, filiform, last joint alone elongated; head elongated, produced in front; rostrum varying in length according to the sex. Usually of a black colour, varied with red or yellow; burrowing under bark of trees.

II. TRIBE.—BENT-HORNED SNOUT-BEETLES (Gonatocerata).

Antennæ elbowed, basal joint elongated, inserted in an elongated canal on side of rostrum.

78. FAMILY.—*Weevils* (Curculionidæ). Antennæ elbowed, basal joint elongate, second joint inserted obliquely at its end, three or four terminal ones forming a club; labrum obsolete; palpi minute, conical; head produced into a rostrum, at the end of which the mouth is placed, its sides with a groove to receive the antennæ; body oval, narrowed in front.

1. *Curculioninæ.* Rostrum short, thick; antennæ inserted near its extremity.
2. *Rhynchæninæ.* Rostrum cylindric or filiform, elongate, antennæ inserted between its base and middle.

79. FAMILY.—*Wood-eating Snout-Beetles* (Scolytidæ). Antennæ short, slightly elbowed, basal joint elongate, apical joints forming a more or less solid mass; labrum obsolete; maxillæ thin, broad, spined externally; palpi conical, minute; body oblong, convex; tibiæ hooked at tip. Burrowing in trunks of trees; causing great injury in pine-forests and parks.

XV. *SUB-ORDER.*—LONGICORN-BEETLES (Longicornes).

Head not produced in front into a rostrum; palpi conspicuous; labrum more or less conspicuous, rarely obsolete; mandibles generally large, robust; antennæ filiform or setaceous, more or less elongate, sometimes very long and slender; body more or less elongated, convex or slightly depressed; eyes generally lunate. Wood eating; larvæ residing in trees.

80. FAMILY. — *Goat-Beetles* (Prionidæ). Antennæ stout, moderate, serrated in the males; eyes notched; labrum very small or obsolete; mandibles large, robust; head not narrowed behind into a neck; thorax transverse, usually toothed on the sides; body elongate, convex. Found on trunks of trees; fly by twilight; colours obscure.

81. FAMILY. — *Musk-Beetles* (Cerambicidæ). Antennæ very long, never serrated; eyes notched; labrum exserted, transverse; maxillary lobes distinct, membranous; head exserted, deflexed; thorax somewhat cylindric, lateral margin sometimes spined; body long and rather flat, occasionally somewhat convex; femora often clavate. Often gaily coloured; found in woods and forests, sitting on trunks of trees; frequently emit a fragrant odour.

82. FAMILY.—*Long-horned Flower-Beetles* (Lepturidæ). Antennæ moderate, inserted before the eyes; eyes entire, rounded or very slightly notched; labrum exserted, transverse; head deflexed, with a distinct neck; thorax somewhat conical, narrowed in front; elytra narrowed behind. Active; usually found upon Umbelliferous flowers in the hot sunshine.

XVI. *SUB-ORDER.*—LONG-LEGGED HERBIVOROUS-BEETLES (Eupoda).

Head not produced in front into a rostrum, deeply inserted into thorax; thorax mostly cylindric, narrower than elytra; elytra elongate, sometimes depressed; body elongate; palpi and labrum conspicuous, labrum generally entire; mandibles short, entire or bifid; antennæ not longer than head and thorax, somewhat filiform, often thickened at tip; eyes entire, rarely emarginate; hind femora more or less clavate and elongate, sometimes toothed.

83. FAMILY.—*Lily-Beetles* (Crioceridæ). Antennæ filiform; eyes prominent; mandibles truncate at tip, with two or three teeth; lower lip entire; head and thorax narrower than abdomen; head immersed nearly to eyes in thorax; thorax cylindric or sub-quadrate; hinder thighs frequently clavate, elongate, sometimes toothed. Usually found on leaves or stems of liliaceous or aquatic plants.

84. FAMILY.—*Thick-Legged Lily-Beetles* (Sagriidæ). Antennæ filiform, inserted before the eyes; eyes prominent; head immersed in thorax; outer lobe of maxillæ broad; mandibles terminated by an acute point; lower lip bilobed; hind femora incrassated and toothed; tibiæ curved. Frequently of brilliant tints.

XVII. *SUB-ORDER.*—SHORT-LEGGED HERBIVOROUS-BEETLES (Cyclica).

Head not produced in front into a rostrum, frequently concealed beneath front of thorax; thorax often as broad at base as elytra; body oval or ovoid, more or less globular; antennæ filiform, or gradually thickened at apex; palpi thickened in middle; labrum distinct; labium thick, square or oval; eyes simple; legs moderate, femora sub-equal, or hind pair much thickened.

85. Family.—*Tortoise-Beetles* (Cassididæ). Antennæ inserted near together, short, slightly thickened towards tips; head concealed beneath front edge of thorax; thorax generally semi-circular; body shield-shaped; sides of thorax and elytra dilated. Generally remain motionless, lying close upon the leaves of plants.

86. Family.—*Spiny Tortoise-Beetles* (Hispidæ). Antennæ filiform, porrect; head exserted; mouth not concealed; palpi short; thorax trapeziform; body oblong, more or less armed with spines; tibiæ compressed. Larva mines the leaves of plants.

87. Family.—*Flea-Beetles* (Galerucidæ). Antennæ approximating at base, exserted, filiform, rather long; palpi with terminal joint thickest in middle; body somewhat oval or hemispherical; elytra wider than thorax; thorax mostly transverse; legs simple; hind thighs often considerably thickened. Often possess the power of leaping. Herbivorous, feeding on the leaves of plants.

88. Family.—*Golden-Beetles* (Chrysomelidæ). An-

tennæ remote, short, moniliform, sometimes rather serrated; palpi short; body generally hemispherical or ovate; thorax with base usually as broad as elytra; legs of equal size, not formed for leaping. Herbivorous; often ornamented with brilliant colours among which gold is conspicuous.

EARWIGS.

The Earwigs form the connecting link between the Beetles and the Orthopterous insects, and remind one especially of the Rove-Beetles, in their long and flattened body, in their short wing-covers, and in the menacing habit they have of presenting their armed tails against their enemies. Although founded on a mistake, the ominous names they have received, as "perce-oreille" and "ear-wig," usually cause them to be regarded with peculiar aversion. The original word was probably Ear-wing, from the shape of the beautiful hind wings, which are so elaborately folded up under their short elytra. These insects are of small size, and of dingy colours, and are widely diffused, being found in North and South America, the Cape of Good Hope, India, and New Holland. In some of the exotic species the forceps at the end of the tail is straight, and as long as the body (*Forficula parallela W.*), while in others, it is singularly contorted, as in *F. macropyga*, *W.* The *Euplexoptera* are nocturnal in their habits, and often migrate in the evening in considerable flocks; they feed on fruits and flowers, and often do great damage in gardens by depriving the petals of dahlias, pinks, and carnations of their symmetry, by their hungry bite, causing the florist to wage against them a war of extermination. The female Earwig sits on her eggs in the manner of a hen, and after the young ones are hatched they follow their mother, who continues to brood over them for many days with true maternal solicitude.

II. ORDER.—EARWIGS (Euplexoptera).

Fore-wings very small, coriaceous, without veins, horizontal, uniting in a straight suture; hind-wings large, membranous, with radiating nervures, and with numerous transverse and longitudinal folds; mouth with transversely moveable jaws, hind pair galeated; tail armed with a forceps. Pupa semi-complete, active, with rudimentary wings.

1. FAMILY.—*Earwigs* (Forficulidæ). Antennæ long, slender, many-jointed; head moderate, flat, narrowed behind into a short neck; eyes small, lateral; ocelli none; jaws small, robust, notched near tip; abdomen ending in a forceps formed of two long, curved, horny appendages pointed at tip, and toothed on inner margin. Fly by night; feed on flowers and fruits.

STRAIGHT-WINGED INSECTS.

Among the cursorial tribes of the *Orthoptera* we find those common pests, the Cockroaches, remarkable for their omnivorous propensities; one of which, the domestic "Black-Beetle" (*Blatta orientalis*), is an importation from our Indian possessions of by no means a satisfactory nature. Here, also, we find the Camel-Crickets or Soothsayers, raptorial insects, so named from their long necks, and the imitative movements of their fore-legs, and which comprise several strange tropical genera, as *Empusa*, with the top of the head formed into a leaf-like lobe, *Eremiaphila*, whose movements are slow, and whose colour resembles that of the sandy plains on which it lives, and *Deroplatys*, with the legs furnished with membranous appendages. In the ambulatorial group, where all the legs are alike, we meet with those phantasms of the insect world, the "Walking-leaves," and the stick-like *Phasma*, which seems made up of dead twigs, and some Australian species, which attain the length of more than a foot.; these curious forms move about the branches of low shrubs in a sluggish manner, either singly or in pairs. In the saltatorial tribes the hind legs are formed for leaping like the Frogs; indeed, some writers have compared the *Orthoptera* with the Batrachian-Reptiles, instancing their loud singing noise, their leaps, and even a singular coincidence of form among certain species. This section includes our familiar merry little friend, the Cricket (*Acheta domestica*); the Mole-cricket (*Gryllotalpa vulgaris*), with its broad, burrowing fore-feet; and that joyous chorister, the Grasshopper, with his less agreeable consimilars, the Migratory-Locusts, so notorious for their devastating powers, and the vast swarms in which they sometimes appear. These latter are herbivorous, the *Mantidæ* are predatory and carnivorous, while the Crickets and Cockroaches are indiscriminate devourers.

III. ORDER.—STRAIGHT-WINGED INSECTS (Orthoptera).

Fore-wings large, coriaceous, thickly-veined, overlapping at tips; hind-wings large, membranous, thickly netted, folded longitudinally; mouth with transversely moveable jaws, the hind pair galeated; tail often styliferous. Pupa active, semi-complete, with rudimentary wings. Chiefly herbivorous; terrestrial.

I. *SUB-ORDER.*—RUNNING-ORTHOPTERA (Cursoria).

Legs long, compressed, formed for running; wings horizontal; fore-legs not raptorial.

1. **FAMILY.**—*Cockroaches* (Blattidæ). Antennæ very long, setaceous, many-jointed; mandibles strong, horny, toothed at tip; upper lip entire; eyes kidney-shaped; ocelli obsolete; body flattened, oval; thorax large, shield-shaped, concealing head; legs long, compressed; tibiæ with spines and spurs; ab-

domen with two jointed appendages at tip. Omnivorous; nocturnal.

II. *SUB-ORDER.*—RAPACIOUS-ORTHOPTERA (Raptoria).

Legs long, formed for walking, the fore-legs larger than the others, formed for seizing their prey; fore-wings long, horizontal when at rest.

2. FAMILY.—*Leaf-Insects* (Mantidæ). Antennæ inserted between the eyes, usually slender and filiform; eyes large, on sides of head; head vertical, exposed; face triangular; ocelli three, in a triangle in middle of forehead; upper lip entire; mandibles horny, trigonal, with acute teeth at tip and a strong tooth at inner margin; thorax produced and narrowed in front, forming a narrow neck, to which the large raptorial fore-legs are attached; hind legs long, slender. Predacious; found on plants and trees, where they remain stationary with the fore-legs raised prepared to seize any insect that comes in their way.

III. *SUB-ORDER.*—WALKING-ORTHOPTERA (Ambulatoria).

Fore-legs of the ordinary form, fitted for walking; hind-legs not saltatorial; fore-wings of small size.

3. FAMILY.—*Stick-Insects* (Phasmidæ). Antennæ usually long, slender, many-jointed, placed

in front of eyes; eyes large, globular; ocelli rudimentary or obsolete; head moderate, oval, sub-depressed, porrect; jaws strong, horny, entire at tip, or with inner margin notched or toothed; thorax greatly elongated; body usually long, slender, sometimes broad, depressed; fore-wings rudimentary; hind-wings, when present, large and membranous; fore-legs not raptorial. Resemble sticks, straws, and leaves; sluggish, solitary, living among low shrubs; herbivorous.

IV. *SUB-ORDER.*—LEAPING-ORTHOPTERA (Saltatoria).

Hind-legs long, formed for leaping, four anterior legs short, simple; wings deflexed at the sides; females with an exserted ovipositor.

4. FAMILY.—*Crickets* (Achetidæ). Antennæ very long and slender; eyes large, round; ocelli distinct, usually two; jaws strong, with several acute transverse teeth; labium four-lobed; body robust, somewhat depressed; wings large, horizontal when at rest; fore-wings when folded forming a pair of long slender filaments; abdomen ending in two slender setæ; tarsi 3-jointed, slender, joints simple on under side. The chirping of the Crickets is produced by rubbing the inner edges of the wing-covers together; the females are mute.

5. FAMILY.—*Grasshoppers* (Gryllidæ). Antennæ

very long and slender; head short, vertical; upper lip rounded, entire; body rather robust; wings large, delicate; wing-covers and wings deflexed in repose; mandibles strongly toothed; ovipositor of female long, sword-shaped; tarsi 4-jointed, joints dilated and obed. The chirping of the Grasshoppers is produced, like that of the Crickets, by rubbing the bases of the wing-covers rapidly together, these organs being furnished with a round talc-like plate, and strong rough ribs serving as a sort of drum.

6. FAMILY.—*Locusts* (Locustidæ). Antennæ short, filiform, cylindric; ocelli three, distinct; upper lip notched on front edge; jaws strong, very much toothed; body robust; laterally compressed; wings and wing-covers deflexed in repose, the latter not furnished with a talc-like plate for stridulation; ovipositor short, not exserted; tarsi 3-jointed. Leap with great force; flight continuous; associate in numbers. Herbivorous. The noise made by the Locusts is produced differently from that of the Crickets and Grasshoppers, and is owing to the friction of the hinder thighs against the sides of the wing-covers.

NET-WINGED INSECTS.

Many of the insects which compose this Order live, during the earlier stages of their existence in the water, where some spend the greater portion of their lives, for no sooner is the nuptial garb assumed, and do their fairy sports commence, than death closes their career, and in the stream which gave them birth they find a grave. Others, as the Dragon-flies, enjoy an ærial existence for a longer period, and pass as rapacious a life in the air as they did before in the water; with powerful flight they course the marsh, the meadow, and the river-bank in search of food, which consists of other insects both in their larval and perfect states. The White-Ants are universally known for the remarkable nests which they construct, wonderful both for size and form; they live mostly either a terrestrial or an arboreal life, possessing wings for a short period only, during the season of courtship, which after that period, fall or are bitten off, leaving them to complete the objects of their existence on foot. The tiny Thunder-Flies which we often find during the summer in countless multitudes, are notorious for the injury they occasionally do to particular plants, and though individually small, the results of their combined operations assume a degree of importance which we cannot pass unnoticed, adding another instance tending to shew, that little objects passed without a thought by thousands, are often those which produce imperceptibly, yet not less certainly, most important changes around us.

IV. ORDER.—NET-WINGED INSECTS (Neuroptera).

Wings four, long, membranous, transparent, traversed by a net-work of nervures, lie flat on the back, carried erect or horizontally when at rest, anterior and posterior pairs often of equal size, posterior pair sometimes very small; antennæ variable, minute, and setiform, or long, filiform or setaceous; legs moderate; abdomen more or less lengthened, cylindrical or depressed, sometimes terminated by filaments.

1. FAMILY.—*Day-Flies* (Ephemeridæ). Head small; eyes large and oval; antennæ very short; body long, slender, soft, terminated by long filaments; wings carried erect when at rest, posterior pair small or wanting; tarsi 5-jointed.
2. FAMILY.—*Hammer-headed Dragon-Flies* (Agrionidæ). Head hammer-shaped; eyes round, lateral, widely separated; mandibles and maxillæ well developed; antennæ very short; abdomen long, slender, cylindrical; wings of equal size, gradually increasing in breadth from the base to near the apex, meeting each other, and carried erect when at rest. Flight feeble and heavy.
3. FAMILY.—*Dragon-Flies* (Libellulidæ). Head large; eyes very large, approximate on top of head; mandibles and maxillæ well deve-

loped, powerful, toothed; antennæ very short; abdomen long, cylindrical or depressed; wings long, of equal size, carried separately and horizontally when at rest. Flight quick and powerful.

4. FAMILY.—*Willow-Flies* (Perlidæ). Head broad; eyes prominent, wide apart; antennæ long, filiform, composed of many joints; body depressed; abdomen sometimes terminated by two slender filaments; wings longer than abdomen, recumbent, posterior pair largest, and folded when at rest.

5. FAMILY.—*White-Ants* (Termitidæ). Head and body depressed, abdomen flat and composed of narrow segments; mandibles strong and horny, toothed; maxillæ terminated by hooked teeth; antennæ of moderate length, moniliform; legs rather short; wings narrow, of equal size, nearly twice the length of body, not much reticulated, semi-transparent. Only males and females have wings, neuters are apterous, and have the head large and the mandibles very long.

6. FAMILY.—*Book-Insects* (Psocidæ). Size small; head large; eyes rather prominent; antennæ long and setaceous; body short, soft, ovate; anterior wings larger than posterior, which are slightly folded, deflected when closed. Often found among books and old papers.

7. FAMILY.—*Thunder-Flies* (Thripidæ). Head oblong; eyes large, distant, placed forward;

antennæ of moderate length, moniliform; body long, linear, depressed; wings four, similar, long, narrow, membranous, very little veined, fringed with silky hairs, laid along the back when at rest; tarsi 2-jointed, vesicular at the tip.

ROOF-WINGED INSECTS.

These insects, in their larval and pupa state, are met with in various situations; some search the stems of plants for *Aphides*, some lurk beneath the bark of trees, others are found in moist earth. The Ant-Lions attract attention from the singular form and habits of their larvæ, which dig pitfalls in the sand, at the bottom of which they lie in wait until some unfortunate insect falls in, when they immediately seize their victim with the long forceps-like mandibles with which they are provided, or, failing in this, and their prey attempts to escape, cast after it a shower of sand, which probably causes it to fall again within their reach; their form contrasts strangely with that of the *imago*, being somewhat spider-like, the body thick and fleshy, and beset with bundles of stiff hairs, and by no means pleasing, while the perfect insect is of graceful figure, with a long slender body and beautiful reticulated wings.

The Water-Moths and their larvæ are well known to the angler as bait, under the names of Caddice-Flies and Caddice-Worms. These latter construct for themselves a curious little house of shells, small pieces of stick, and other such materials, kept together by threads similar to those spun by caterpillars; in this tube-like home they dwell, at the bottom of streams, and in it undergo their metamorphosis into the *pupa* state; when about to assume the perfect form they crawl out of the water up the stem of some plant, cast their exuvia, and become denizens of the air.

Thus, from forms singular, grotesque, and most unlike, proceed those which can scarcely fail to arrest our gaze and excite our admiration.

V. ORDER.—Roof-winged Insects (Stegoptera).

Wings four, large, membranous, often beautifully reticulated, frequently dissimilar, deflexed when not in use, never carried erect, seldom porrected, anterior pair sometimes hirsute, posterior generally folded when at rest; antennæ more or less lengthened, filiform, multiarticulate, sometimes pectinate, occasionally shorter and clavate; abdomen usually of moderate length and cylindrical; legs often long and slender.

1. Family.—*Scorpion-Flies* (Panorpidæ). Head produced into an elongated deflexed rostrum; eyes prominent; antennæ long, slender, many jointed; anterior segment of thorax forming a narrow collar; body slender, posterior segments of abdomen narrowed, the last segment in the males sometimes armed with a pair of forceps; wings variable, sometimes porrected

when at rest, with posterior pair much lengthened and linear, sometimes large, similar, and roof-like when at rest, sometimes rudimentary.

2. FAMILY.—*Snake-Flies* (Raphidiidæ). Head flattened; eyes prominent; antennæ slender, many jointed; anterior segment of thorax narrow and much lengthened (whence their English name); mandibles strong, corneous; abdomen of moderate length, terminated, in the females, by a long sabre-like ovipositor; wings rather large, posterior-pair rather smaller than the anterior, strongly veined.

3. FAMILY. — *Mantis-Flies* (Mantispidæ). Head broad, flat; eyes prominent; antennæ short, sub-moniliform; anterior segment of thorax narrow and much lengthened, often transversely furrowed; fore-legs long, attached close to the head, and formed as in *Mantis*, having the thighs large, compressed and armed with spines, and the tibiæ curved; abdomen of moderate length; wings of nearly equal size, beautifully reticulated.

4. FAMILY.—*Ant-Lions* (Myrmeleonidæ). Head rather small, transverse; eyes prominent; antennæ usually of moderate length, hard, thickened and curved at tip, sometimes longer and nearly filiform; abdomen long, slender and cylindrical, sometimes terminated by two filiform appendages; wings long, of equal size, delicately reticulated.

5. FAMILY.—*Lace-Wings* (Hemerobiidæ). Head small; eyes prominent, often of a brilliant metallic lustre; antennæ long, filiform, composed of many joints; first segment of thorax small; abdomen soft, of moderate length; wings large, very delicate, posterior pair rather smaller than anterior.
6. FAMILY.—*May-Flies* (Sialidæ). Head moderate, transverse; antennæ long, filiform, sometimes pectinated and many jointed; first segment of thorax as large as the head; abdomen not long; anterior wings very large, posterior a little smaller, carried horizontally or deflexed along sides of body, hind-wings folded when at rest.
7. FAMILY.—*Water-Moths** (Phryganeidæ). Head small; eyes prominent; antennæ slender, setaceous or pectinated, generally longer than the body; wings roof-like, membranous, of nearly equal size, nerves simply branching, anterior pair generally pilose, posterior transparent and folded when at rest; abdomen rather soft; legs long and slender; tibiæ spurred.

CLEAR-WINGED INSECTS.

This Order is very extensive, comprising about a fourth of the entire insect race; its members are especially numerous in tropical regions, while, in our own country, we may reckon three thousand species.

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* Called also "Caddice-Flies."

It is among the hymenopterous tribes that we find those remarkable social communities, where the workers consist of abortive females, where the idle drones are the males, and where one chosen female is elected queen, and made the prolific mother of an entire generation. The nectar of flowers is the favourite drink of these active, bustling, tribes in their perfect state; but when we see the busy Bees intent upon fresh-blown flowers, we must not imagine the luscious banquet spread for themselves alone, it is for the young of the community, yet unborn, that they labour to collect the honey and the pollen. In the same manner, when we spy out a robber wasp dragging away the dead carcase of a fly bigger than herself, it is for the sustenance of her future progeny that the deed of poisoning was done. The Aphidian cows kept by Ants, and watched with so jealous a care, are valued only for the honey-dew they yield, and with which they nourish their young ones.

Belonging to this Order we find the Saw-Flies, which make incisions into the leaves and stems of plants, by means of elaborately-formed saws, placed at the end of their bodies, and the larvæ of some species of which live in societies covered over with a tent of leaves, fastened together by silk. The Gall-Flies are another remarkable race, which puncture the surface of plants, by means of a boring instrument, and, by depositing their eggs in the punctures, produce "galls" of various kinds; to the "gall" produced by one species we are indebted for our ink, that most important fluid in the history of learning and civilization. Here also we find the Ichneumon-Flies, which deposit their eggs in the bodies of other insects, and which are eventually devoured by the parasites. In tropical countries, species of *Sphegidæ* will be observed, forming nests in the corners of the rooms, composed of several earth-cells, in each of which the mother *Pelopæus* deposits a green caterpillar. The Velvet-Ants are also numerous in equatorial regions, and may be seen running briskly about in hot, sandy, situations. Nor must we omit to mention the Ants-proper, those memorable little insects, which live in societies like the social bees; and the Social-Wasps, which manufacture galleries of hexagonal cells out of paper, and surround their cities with a wall; and, lastly, the Honey-Bees, those oft-quoted examples of industry, loyalty, and good order, which live gregariously, and form elaborate houses, to the robbery of which we owe our honey and our wax.

VI. ORDER.—CLEAR-WINGED INSECTS (Hymenoptera).

Wings four, naked, membranous, hind pair the smallest and few-veined; mouth with horny jaws, and with a lower lip or tongue sheathed by the maxillæ; abdomen in females armed with an ovipositor or sting; tarsi usually five-jointed. Larva usually vermiform, apodal; pupa inactive, incomplete.

I. *SUB-ORDER.*—Stingless-Hymenoptera (Terebrantia).

Abdomen of females furnished with a saw or borer for depositing the eggs.

I. TRIBE.—Saw-bearing Hymenoptera (Securifera).

Abdomen sessile; larvæ with a well-developed mandibulated mouth. Feeding upon vegetable matter.

1. Family.—*Saw-Flies* (Tenthredinidæ). Antennæ variable, usually short, of males often pectinate, furcate, or flabellate; mandibles elongate, narrow, compressed, toothed; thorax solid, broader than head; abdomen sessile, of female furnished with a pair of saws; wings ample, with numerous complete cells; hind-tibiæ often spurred. Introduce their eggs by sawing edges of leaves, or by making incisions in their surface.
    1. *Tenthredininæ.*—Antennæ 9—11-jointed, simple, filiform to tip; labrum apparent; saws with parallel sides.
    2. *Cimbicinæ.*—Antennæ short, clavate, with not more than eight joints; larvæ 22-footed, emitting drops of viscid matter.
    3. *Hylotominæ.*—Antennæ 3-jointed, terminal joint greatly elongated; labrum apparent; larvæ 18—20-footed, not emitting drops of viscid matter.
    4. *Lydinæ.*—Antennæ many-jointed, sometimes

strongly pectinate in males; hind-tibiæ often spined in middle; saws slightly serrated at tip; dilated and elbowed at base; larvæ various.

2. **Family.**—*Auger-Flies* (Uroceridæ). Antennæ filiform or setaceous, vibratile; head rounded, as broad as thorax; upper lip minute, elongated; mandibles short, strong, horny; trophi irregular; prothorax and collar elongated; body elongated, sub-cylindrical; abdomen sessile, furnished in females with a borer or awl-like ovipositor; fore-tibiæ with a single spur. Females deposit their eggs in timber by means of their powerful boring instrument.

II. TRIBE.—Parasitic-Hymenoptera (Pupivora).

Abdomen attached to thorax by a portion only of its transverse diameter; larvæ with slightly-developed mandibulated trophi, for the most part feeding parasitically upon other living insects; abdomen with an elongate, many-valved oviduct.

3. **Family.** — *Gall-Flies* (Cynipidæ). Antennæ straight, inserted in middle of face, long, slender; labrum minute; mandibles short, robust, toothed at tip; maxillæ with a broad ciliated lobe; head small, transverse; palpi short; wings with few veins; abdomen oval, compressed, basal joint largest, the others imbricate; peduncle short; ovipositor spiral, retractile when at rest. Females deposit

their eggs in the tissues of plants and produce the tumours known as "galls."

4. FAMILY.—*Thick-legged Ichneumon-Flies* (Evaniidæ). Antennæ straight, filiform or setaceous; mandibles toothed on inside; fore-wings with several irregular cells; hind-wings without veins; abdomen attached to dorsum of metathorax by a peduncle often arising close to scutellum; ovipositor straight; hind-legs elongated, tibiæ often thickened. Parasitic on other insects.

5. FAMILY. — *Ichneumon - Flies* (Ichneumonidæ). Antennæ straight, usually filiform or setaceous; head small, free; eyes large, lateral; mandibles slender, curved, bidentate at tip; wings veined, anterior with perfect cells; body long, narrow; abdomen attached at extremity of thorax between base of hind coxæ; ovipositor straight, often exserted; legs long, formed for running; tarsi long, slender. Pupa enclosed in a cocoon. Usually black, varied with red, yellow, and white. Females deposit their eggs in larvæ or pupæ of other insects.

    1. *Ichneumoninæ.*—Wings with two recurrent nerves; nerve separating first cubital cell from external discoidal cell nearly or entirely obliterated; an articulation between second and third dorsal segments of abdomen.

    2. *Braconinæ.*—Wings with only one recur-

rent nerve, which unites with the nerve extending between first cubital and external discoid cells; no articulation between second and third dorsal segments of abdomen.

6. FAMILY.—*Cuckoo-Flies* (Chalcididæ). Antennæ elbowed, thickened at tips; palpi short; mandibles broad, horny, ending by several teeth; head transverse; eyes lateral, often very large; wings nearly destitute of veins; abdomen varied in shape, attached by a peduncle, or nearly sessile; ovipositor usually concealed, not longer than abdomen; hind-legs often toothed and thickened. Pupa naked. Parasitic on other insects.
    1. *Chalcidinæ.* Collar transverse, quadrate; hind femora thickened.
    2. *Eurytominæ.* Collar transverse, quadrate; hind femora simple.
    3. *Pteromalinæ.* Abdomen flat, sessile; antennæ filiform, fusiform, or clavate; stigmal branch straight.
    4. *Eupelminæ.* Abdomen flat, sessile; antennæ filiform, fusiform, or clavate; stigmal branch incurved.
    5. *Encyrtinæ.* Collar more or less narrowed in front; antennæ with not more than eight joints; middle legs strongly spurred.
    6. *Eulophinæ.* Collar more or less narrowed in front; antennæ with not more than eight joints; tarsi with less than five joints.

7. FAMILY.—*Sharp-tailed Cuckoo-Flies* (Proctotrupidæ). Antennæ more or less elbowed; palpi long and pendulous; mandibles long, somewhat sickle-shaped, notched at tip; eyes entire; ocelli three; abdomen usually ovate-conic; ovipositor elongate, conic, acute, formed of two united pieces, enclosed in a tube, or exposed; fore-wings veinless, or with few veins; body long and slender; legs long, femora often clavate; anterior-tibiæ with a terminal curved spur. Very active, usually black, varied with brown; minute; found in grass, on aquatic plants, or in hot sandy situations. Parasitic. Females deposit their eggs in other insects.

1. *Mymarinæ.*—Head transverse, areolate; antennæ inserted above middle of face, long, slender in males,—clavate, elbowed in females; palpi none; wings narrowed, densely ciliated.
2. *Platygasterinæ.*—Abdomen sessile, depressed, first segment not campanulate; antennæ elbowed, 10–12-jointed, inserted near mouth.
3. *Ceraphrontinæ.*—Abdomen sub-sessile, campanulate; terminal and ventral segment carinated; antennæ elbowed; wings nearly exareolate.
4. *Gonatopinæ.*—Abdomen convex, not campanulate; last ventral segment carinated; antennæ porrected, 10-jointed; hind-wings lobed; mandibles toothed.

5. *Proctotrupinæ.*—Abdomen sub-sessile, campanulate; antennæ porrected, 12-jointed, inserted beneath front; maxillary lobe bipartile.
6. *Diapriinæ.*—Abdomen petiolated, campanulate; antennæ 10—15-jointed, inserted in front; maxillary palpi long, 5-jointed.

III. TRIBE.—TUBE-BEARING HYMENOPTERA (Tubulifera).

End of abdomen tubular, retractile, furnished with a minute sting. Larvæ feeding on other insects. Parasitic on other Hymenoptera.

8. FAMILY.—*Ruby-tailed Flies* (Chrysididæ). Antennæ filiform, elbowed at end of long basal joint; head transverse above; maxillæ ending in a large pilose outer lobe; mandibles long, sub-trigonal; thorax oblong, metathorax armed on each hind margin with a spine; fore-wings with a single marginal cell; hind-wings nearly veinless; abdomen with under side concave, with a very short peduncle, terminal segments telescopic, retractile; ovipositor sting-like, with two styles of the same length. Adorned with brilliant metallic tints; fly and run in the hot sunshine with great vivacity.

II. *SUB-ORDER.*—STINGING-HYMENOPTERA (Aculeata).

Abdomen of females armed with a sting connected with a poison reservoir.

I. TRIBE.—HETEROGYNOUS-HYMENOPTERA (Heterogyna).

Fore-wings not folded; larvæ social.

9. FAMILY.—*True-Ants* (Formicidæ). Antennæ elbowed; eyes distinct; thorax continuous, more or less contracted in middle; abdomen without a sting, peduncle composed of a single elevated scale. Males and females with wings; neuters wingless. Social and gregarious.
10. FAMILY.—*Stinging-Ants* (Myrmicidæ). Antennæ elbowed; eyes distinct; thorax continuous, more or less contracted in middle; abdomen armed with a sting, peduncle 2-jointed; males and females with wings; neuters wingless. Social and gregarious.
11. FAMILY.—*Blind-Ants* (Poneridæ). Antennæ elbowed; eyes of neuters obsolete; thorax continuous, more or less contracted in middle; abdomen armed with a sting, peduncle formed of one large scale; males and females with wings; neuters wingless. Social and gregarious.
12. FAMILY.—*Velvet-Ants* (Mutillidæ). Antennæ inserted in middle of face; thorax continuous, the segments soldered together; ocelli wanting; body clothed with hair; abdomen armed with a sting, peduncle short, simple; legs robust; tibiæ and tarsi spined and ciliated; females destitute of wings. Solitary. Males and females, no neuters.

II. TRIBE.—FOSSORIAL-HYMENOPTERA (Fossores).

Fore-wings not folded; larvæ solitary, feeding on other insects.

13. FAMILY.—*Spine-tailed Wasps* (Scoliidæ). Antennæ short, thick, more or less serrated and convolute in the females; collar laterally dilated, extending as far as bases of wings; abdomen ovate, peduncle short; abdomen of males ending in three spines; legs short, robust; tibiæ thick, spinose, or denticulated; both sexes winged. Burrow in sand.

14. FAMILY.—*Parasitic Spine-tailed Wasps* (Sapygidæ). Antennæ long, straight, more or less clavate; collar laterally dilated, extending as far as bases of wings; abdomen ovate; peduncle short; legs slender; fore-legs not ciliated in the females; both sexes winged. Parasitic in nests of bees; live and burrow in sandy situations.

15. FAMILY.—*Dark-winged Sand-Wasps* (Pompilidæ). Antennæ filiform, often convoluted in females; collar laterally dilated, extending as far as bases of wings, transversely or longitudinally quadrate; abdomen more or less oval, attached to thorax by a short peduncle; legs very long; fore-wings with two or three perfect sub-marginal cells. Burrow in sandy places.

16. FAMILY.—*True Sand-Wasps* (Sphegidæ). Antennæ filiform, often convoluted in females;

collar laterally dilated, extending as far as bases of wings; abdomen elongate, attached to thorax by a long peduncle; body narrow; legs, especially the hind pair, very long; fore-legs strongly ciliated; hind-tibiæ spurred in females. Nidificate and burrow in sand.

17. FAMILY.—*Beaked Sand-Wasps* (Bembecidæ). Head transverse; mandibles acute, with a tooth on inside; jaws produced into a long beak; collar minute, not extending to bases of wings; body elongate, tapering behind; legs short, fore-legs strongly ciliated. Form burrows in sandy situations.

18. FAMILY.—*Ichneumon Sand-Wasps* (Larridæ). Head moderate; mandibles with a deep notch on outer side near base; jaws not prolonged into a beak; collar small, not extending to base of wings; abdomen sub-conical and not peduncled; legs moderate, ciliated in females. Perforate the sand, in which they nidificate.

19. FAMILY.—*Bee-like Sand-Wasps* (Nyssonidæ). Head moderate; antennæ filiform, basal joint slightly elongated; mandibles slightly notched on outside of base; jaws not prolonged into a beak; abdomen ovoid-conic, broadest at base, not peduncled; fore-tibiæ with a dilated spur. Nidificate in sandy localities.

20. FAMILY.—*Predacious Wood-Wasps* (Crabronidæ). Head large, square; antennæ straight or somewhat elbowed, often thickened at tip; mandibles with outer margin entire; jaws

not prolonged into a beak; abdomen oval, broadest in middle or clavate, peduncled; fore-tibiæ with a dilated spur. Usually burrow in old wood, and occasionally in sandy places.

III. TRIBE.—FOLDED-WINGED HYMENOPTERA (Diploptera).

Fore-wings folded on themselves. Larvæ, in the social species, separately enclosed in cells.

21. FAMILY.—*Solitary-Wasps* (Eumenidæ). Antennæ of males curved at tips; eyes notched; mandibles elongate, produced; labium divided into four pilose setæ ending in glands; wings folded when at rest; abdomen contracted, with a long narrow peduncle; legs not ciliated or spinose. Solitary. Males and females only. Form cells of sand and clay.

22. FAMILY.—*Social-Wasps* (Vespidæ). Antennæ of males not hooked or recurved at tip; eyes notched; mandibles as broad as long, truncate at end; wings folded when at rest; abdomen rarely contracted into a peduncle; hind-tibiæ with two spurs. Social. Males, females, and neuters. Form cells of paper arranged in tiers.

IV. TRIBE.—HONEY-GATHERING HYMENOPTERA (Mellifera).

Basal joint of hind-tarsi dilated, provided with instruments for collecting and carrying pollen; larvæ living on honey.

24. Family.—*Solitary-Bees* (Andrenidæ). Labium small or cordate; jaws moderate, not forming an elongated proboscis; hind-legs generally clothed with hair; trochanters and femora in the females pollenigerous; basal joint of hind-tarsi not dilated into an angle. Solitary. Males and females only.

25. Family.—*Social-Bees* (Apidæ). Labium long and filiform; jaws extended into an elongated proboscis usually folded up beneath the head; basal joint of hind-tarsi externally dilated and angled; the second joint arising from the inner angle of the preceding joint. Social. Males, females, and neuters.

II. *SUB-CLASS.*—Suctorial-Insects (Haustellata).

Mouth produced into a more or less elongated proboscis.

SCALY-WINGED INSECTS.

The *Lepidoptera* have been arranged into those that fly by day, or the Butterflies, those that come forth at twilight, or the Hawk-moths, and those that are nocturnal in their flight, as the Moths properly so called. On account, however, of the number of exceptional cases, we have followed M. Boisduval, and thrown them into two divisions, or those with clubbed and those with varied antennæ. As humble worms, toiling and spinning, these insects are usually despised; wrapped in their mummy-clothes, as inert grubs, they are forgotten; but when they come forth glorious in their *Psyche* state, "all with admirable beauty deck't," they are admired and sought after; a fit subject for a moral. It is in this form of beauty, when they add an extra charm to the smiling landscape of summer, and make the glory of the woods yet more attractive, that they become the favourite Order, with many, among all the insects. The illustrious Swede, Linnæus, conceived the poetic idea of naming the butterflies after the heroes and heroines of the Iliad, thus recalling to memory the glorious verse of the "blind old bard of Scio's rocky isle." Those clothed in sombre colours he called Trojans, and those clad in gay attire, he christened Greeks; and her he regarded as the greatest beauty, was *Papilio Helena.* The night-flyers are no less worthy of consideration than the more highly-coloured lovers of the sun. Some are remarkable for their size and vivid painting, as *Saturnia Atlas,* which often measures nine inches across the wings; others for the valuable web they spin in their caterpillar state, as the Silkworm-moth (*Bombyx mori*); some are notorious for the injury they inflict on certain trees, as the Goat-moth (*Cossus ligniperda*); others attract notice by their large size and powerful flight, as the Hawk-moths; while some, again, present the peculiarity of being infested by *fungi,* as the *Hepialus virescens,* or New Zealand Swift-moth, the caterpillar of which is often entirely converted into a fungus

(*Sphœria Robertsi*). During the summer time in New Holland, the natives of certain tribes principally subsist upon a species of Butterfly, which then occurs in countless myriads, and which they collect, bake, and form into smoked cakes. In their caterpillar or larval condition these insects often assist in the removal of offending substances, and tend also to keep in check the superabundance of vegetation, which might, otherwise, become too luxuriant in its growth.

VII. ORDER.—SCALY-WINGED INSECTS (Lepidoptera).

Wings four, large, extended, membranous, clothed on each side with imbricate scales; neuration branching; mouth in form of a spirally-involute proboscis; thorax ovate, with lateral appendages (*patagia* and *tegulæ*); tibiæ spurred. Pupa covered with a skin.

I. *SUB-ORDER.*—BUTTERFLIES (Rhopalocera).

Antennæ slender, elongated, ending in a knob; wings erect during repose, not connected by a hook and bristle; hind-tibiæ spurred. Chrysalis angulated, usually naked. Diurnal.

1. FAMILY.—*Butterflies-proper* (Papilionidæ). Antennæ with the club distinct, never hooked at tip; labial palpi with third joint rudimentary, or clothed with scales; all four wings elevated in repose; central cell of hind-wings closed; tibiæ with only one pair of spurs at the end; all the feet fit for walking and nearly alike; tarsal claws large. Cater-

pillar nearly cylindrical; chrysalis girt round the middle as well as attached by tail.

1. *Papilioninæ.* — Anal edge of hind-wings hollowed or folded.
2. *Pierinæ.* —Anal edge of hind-wings produced under abdomen, forming a kind of gutter.

2. FAMILY.—*Simple-winged Butterflies* (Heliconiidæ). Antennæ with club distinct, never hooked at tip; labial palpi with third joint rudimentary or scaly; all four wings elevated in repose; central cells of hind-wings closed; tibiæ with only one pair of spurs at end; fore-legs shortened, unfitted for walking, small; tarsal claws large, with a long appendage on each side; wings entire, often long and narrow, sometimes nearly naked. Caterpillar nearly cylindrical; chrysalis simply suspended by tail.

3. FAMILY.—*Tooth-winged Butterflies* (Nymphalidæ). Antennæ with club distinct, never hooked at tip; labial palpi with third joint rudimentary or scaly; all four wings elevated in repose, central cell of hind-wings open; tibiæ with only one pair of spurs at end; fore-legs shortened, unfitted for walking, visible and hairy, or small and concealed; wings dentate, hinder grooved for abdomen; tarsal claws with a brush or *pulvillus.* Caterpillar nearly cylindrical; chrysalis simply suspended by tail.

4. **Family.** — *Clawless - Butterflies* (Erycinidæ). Club of antennæ distinct, not hooked at tip; labial palpi with third joint naked; all four wings elevated in repose; anal edge of hind-wings slightly prominent; discoidal cell open or closed; tibiæ with only one pair of spurs; fore-legs of males rudimentary; tarsal claws obsolete. Caterpillars short, hairy; chrysalis girt round middle as well as attached at tail.

5. **Family.**—*Eye - winged Butterflies* (Polyommatidæ). Club of antennæ distinct, not hooked at tip; labial palpi with third joint naked; all four wings elevated in repose; anal edge of hind-wings embracing abdomen; discoidal cell closed; fore-legs fitted for walking; tibiæ with only one pair of spurs; tarsal claws minute. Caterpillars like wood-lice; chrysalids girt, as well as attached by tail.

6. **Family.** — *Skippers* (Hesperiidæ). Antennæ ending in a strong hook; two hind-wings horizontal in repose; feet of uniform size; hind-tibiæ furnished with two pairs of spurs. Caterpillars cylindrical, roll up leaves; spin a silken cocoon; chrysalids without angular prominences.

II. *SUB-ORDER.*—MOTHS (Heterocera).

Antennæ filiform or fusiform, those of the males often pectinated; wings connected by a hook and bristle; chrysalids without angular projections, usually enclosed in a cocoon. Mostly night-flyers.

7. FAMILY.—*Butterfly Hawk-Moths* (Uraniidæ). Antennæ long and variable, not prismatic, nor ending in a brush; proboscis elongated; fore-tibiæ spurred; wings expanded in repose. Caterpillar cylindrical, with slender bristles; chrysalis enclosed in a lax cocoon. Flight diurnal.

8. FAMILY.—*Hawk-Moths proper* (Sphingidæ). Antennæ prismatic, ending in a little feather or thread; proboscis greatly elongated; body long, acute behind; wings narrow, the hinder small. Caterpillars naked, usually with a horn on hind part of back.

9. FAMILY.—*Burnet Hawk-Moths* (Anthroceridæ). Antennæ simple, fusiform, pectinated in the males; wings deflexed in repose; legs long; hind-tibiæ with four spurs. Caterpillars clothed with short hairs, without any spine. Day-flyers.

10. FAMILY.—*Clear-winged Hawk-Moths* (Ægeriidæ). Antennæ simple, fusiform, usually ending in a pencil of hairs; proboscis elongated; wings more or less transparent; legs elongate, the hinder with long spurs; abdomen ending in a dilatable brush. Caterpillars naked, without a caudal horn.

11. FAMILY.—*Swift-Moths* (Hepialidæ). Antennæ short and filiform, not feathered at tip; proboscis short or obsolete; wings elongated,

deflexed in repose; abdomen produced into a retractile ovipositor. Caterpillars naked, with a few straggling hairs.

12. FAMILY. — *Lappet-Moths* (Bombycidæ). Antennæ of males strongly pectinate; proboscis obsolete; body thick and hairy; wings large, extended, or deflexed at the sides, the hind pair extending beyond the costa of the interior. Caterpillar with a series of tufted warts.

13. FAMILY.—*Tiger-Moths* (Arctiidæ). Antennæ of males strongly pectinate or serrated; proboscis small or obsolete; wings deflexed in repose, the hinder not extending beyond the costa of the anterior. Caterpillars naked, tubercled, or hairy.

14. FAMILY.—*Lackey-Moths* (Lithosiidæ). Antennæ setaceous; proboscis elongate, spiral; thorax not crested; body slender; wings elongated, horizontal in repose. Caterpillars cylindrical, somewhat hairy.

15. FAMILY.—*Rustic-Moths* (Noctuidæ). Antennæ simple, rarely pectinate in the males; body robust; thorax stout, often crested; wings deflexed in repose, moderate, the anterior usually with ear-shaped spots; proboscis greatly elongated and spiral. Caterpillars naked.

16. FAMILY.—*Geometric-Moths* (Geometridæ). Antennæ variable; proboscis short, weak, membranous; body slender; thorax never crest-

ed; wings large, extended horizontally; legs slender, fore-tibiæ armed internally with a spur. Caterpillars naked, looping.

17. Family.—*Meal-Moths* (Pyralidæ). Antennæ simple or ciliated in the males; proboscis moderate; thorax never crested; body slender, elongated; wings moderate, arranged in a triangle during repose; the anterior angled at tip. Caterpillars long and slightly hairy.

18. Family.—*Leaf-rolling Moths* (Tortricidæ). Antennæ simple; fore-legs with a central spur; body slender; fore-wings broad, deflexed at the sides, dilated at the shoulders, forming a triangle in repose. Caterpillars naked, living in cylindric tubes which they form by rolling up leaves.

19. Family.—*Ermine-Moths* (Yponomeutidæ). Antennæ long, slender, simple; labial palpi long and slender; maxillary palpi slightly developed; body slender, rather depressed, wings entire, long and narrow, the hinder fringed with very long cilia. Caterpillars often living under the parenchyma of leaves.

20. Family.—*Clothes-Moths* (Tineidæ). Antennæ moderate, slender, simple, pubescent beneath in the males; proboscis short; thorax rarely crested; body long and slender; wings entire, often narrow, mostly convoluted in repose. Caterpillars usually living in portable cases, which they form of various materials.

21. FAMILY.—*Plume-Moths* (Alucitidæ). Antennæ long, slender, setaceous; proboscis long and spiral; body elongated; wings horizontal in repose, cleft into narrow, feathered rays; legs long and slender. Caterpillars clothed with long hairs.

BUGS.

Among the members of this Order many singular and strange forms are to be met with. They abound in gay and lively colours, in which, perhaps, they are exceeded by few of the Insect-Tribes. Green, gold, purple, scarlet, and similar brilliant hues frequently adorn them, as in the *Coleoptera*, their assemblage, and bold contrasts being very similar in both Orders. Many of these insects live chiefly in the water, having greatly depressed bodies, and their legs formed into natatory organs; others run upon the surface of the water, as the little *Velia currens*, which may be seen during the summer months in great numbers about our rivulets and ditches. But it is upon plants that the majority are to be found, and from which they draw their nourishment, piercing them and extracting the fluids; a few attack man, as the common bed-bug (*Cimex lectularius*), and some suck the juices from other insects. We observe in them a fine adaptation for drawing nourishment in this manner; the mouth is formed into a long jointed canal enclosing several fine bristle-like lancets, which are used in perforating the substances on which they feed. When not employed, this rostrum is laid along the ventral surface of the body, and often extends two thirds of its length.

These insects arrive at maturity by a series of moultings; they have no inactive pupa state, but both as larvæ and pupæ continue lively and feeding, and in general appearance bear a strong resemblance to the perfect insects, the principal difference being the absence of wings in the larva and the possession of these, in an immatured state, and enclosed in cases, on the back of the pupa. When arrived at this stage, one moult completes the tranformation to the imago.

Most of them possess the property of emitting a strong, and generally very disagreeable odour when handled or crushed.

VIII. ORDER.—Bugs (Hemiptera).

Body depressed; wings generally horizontal, anterior pair coriaceous at the base, membranous at the terminal part; antennæ usually long; mouth in the form of a long jointed canal, which, when unemployed, is laid along the ventral surface of the body.

The larvæ and pupæ differ from the perfect insect only in not possessing wings, at which last state they arrive by a succession of moultings.

I. *SUB-ORDER.*—Water-Bugs (Hydrocorisa).

Antennæ very short, concealed beneath the eyes;

fore-legs fitted for seizing prey, posterior pair ciliated, and formed for swimming. Aquatic.

1. FAMILY. — *Boat-Flies* (Notonectidæ). General form boat-shaped; head broad; eyes very large, and so formed that the insect may see both above and below when swimming; wings generally deflexed; posterior legs long and broadly ciliated, forming excellent paddles.
2. FAMILY. — *Water-Scorpions* (Nepidæ). Head small; rostrum short; body depressed; abdomen sometimes terminated by two long slender filaments; fore-legs especially adapted for seizing prey, the thighs being dilated, the tibiæ curved, united with the tarsus, and fitting in a channel on the under part of the thighs.

II. *SUB-ORDER.*—LAND-BUGS (Geocorisa).

Antennæ usually long, very seldom concealed, legs fitted for walking. Terrestrial, or only found, in a few cases, on the surface of the water.

3. FAMILY.—*Sand-Bugs* (Galgulidæ). Eyes pedunculated; body short and depressed; antennæ small, placed in a cavity beneath the eyes; rostrum short. In some the wing cases are soldered together at the suture.
4. FAMILY. — *Jumping-Bugs* (Acanthiidæ). Eyes large; rostrum long and slender; body depressed, oval; legs long; antennæ long or short. Of small size.

5. Family. — *Water-Measurers* (Hydrometridæ). Head generally as broad as thorax; antennæ long, 4-jointed; rostrum of moderate length; body long, narrow, clothed on ventral surface with a fine down; legs long. Found running on the surface of water.

6. Family.—*Long-necked Bugs* (Reduviidæ). Head small, narrowed behind into a sort of neck; eyes prominent; rostrum rather short, robust; antennæ long, terminal joints very slender; thorax frequently spined; body variable, long and narrow, short, or abdomen much dilated and very thin at the edges; legs long.

7. Family.—*Bed-Bugs* (Cimicidæ). Body very flat; wings rudimentary, in the form of small scales; antennæ 4-jointed; legs slender, of moderate length.

8. Family. — *Bark-Bugs* (Tingidæ). Size small; body very flat and broad; antennæ moderate, of equal thickness throughout, sometimes knobbed; rostrum very short, 3-jointed; fore-legs occasionally fitted for seizing prey; thorax sometimes having a membranous dilatation in place of a scutellum, which, with the hemelytra, are reticulated.

9. Family. — *Soft-bodied Bugs* (Capsidæ). Size small; body convex; antennæ elongated, second joint thickened at the end, terminal joints slender; rostrum long, 4-jointed; legs long and slender, hind-legs sometimes very

elongate with the femora thickened, fitted for jumping. The females have a rather long sabre-shaped ovipositor which fits into a groove on the under side of the abdomen.

10. FAMILY.—*Painted-Bugs* (Lygæidæ). Size small or moderate; body generally narrow; antennæ 4-jointed, not thinner at apex; rostrum of moderate length; apical membrane of wing-covers longitudinally nerved, membrane sometimes absent; some have the fore-legs thickened. Remarkable for their varied colours.

11. FAMILY.—*Club-horned Bugs* (Coreidæ). Frequently of large size; form elongate, often slender; antennæ 4-jointed, terminal joint large, thickened or elongate, sometimes one of the intermediate joints dilated; rostrum rather long; apical membrane of wing-covers generally having numerous longitudinal nerves; legs long, femora sometimes much thickened, curved and spined, tibiæ occasionally curved and hooked.

12. FAMILY.—*Shielded-Bugs* (Scutelleridæ). Size moderate or large; colours varied, often splendid; scutellum generally very large, sometimes covering abdomen; rostrum long, 4-jointed; antennæ long, usually 5-jointed; body generally rather short and oval; mesosternum sometimes elevated in the form of a keel, or produced into a spine; legs moderate.

SIPHON-MOUTHED INSECTS.

The *Homoptera* have also been termed "plant-suckers," on account of their feeding on the juices of vegetables. The Order comprises many most anomalous forms; some having curved horns on their backs like the *Centrotus* and *Membraces*, and others being provided with hollow appendages on their heads as the Lantern-Flies. Some among them, as the *Aphides*, or plant-lice, have the extraordinary faculty of producing living young ones without a previous union with the other sex, which power may be exercised through as many as nine generations. Madam Merian has stated that the Lanthorn-Fly of South America is luminous by night; the Chinese species kept alive by one of the Authors, shewed however, no signs of luminosity either by night or day. The insects celebrated in the songs of the ancient Greek and Roman poets (*Cicada plebeia*), on account of the loud chirping they produce as they sit among the leaves of the trees, belong to this Order. The "Cuckoo-spit," often seen on the leaves of plants, is produced by the larva of *Aphrophora spumaria;* and another species, *A. Goudotii*, a native of Madagascar, has the singular power of emitting a considerable quantity of clear water during the greatest heat of the day.

These insects are often highly injurious to vegetation, for example the American blight, *Lachnus lanigerus,* and the species of *Coccus* that infests the vine and other plants in hot-houses. The *Cicada septendecem* sometimes appears in America in prodigious numbers, and does great injury to the timber. Their numbers on these occasions are so great as to break the branches of the trees by their weight, and the noise of their discordant drums is heard in the woods from morn to eve. Another instance of the damages occasioned by some of them is seen in the Sugar-cane Fly, *Delphax saccharivora*, so injurious to the West-Indian plantations. On the other hand, the fine white wax manufactured by the Chinese, and highly prized in the East Indies, is obtained from species of *Hata* in an immature state. Cochineal is produced from the *Coccus cacti;* the "scarlet grain" of Poland, also a valuable dye, from *Coccus Polonicus;* lac is derived from *Coccus lacca;* the *Coccus ceriferus* is used in the production of a white wax; and the manna of Mount Sinai is owing to the punctures of *Coccus manniperus* on the *Tamarix mannifera.*

IX. ORDER.—SIPHON-MOUTHED INSECTS (Homoptera).

Wings four, entirely membranous, deflexed; anterior the largest, not overlapping in repose; antennæ short, setigerous; mouth produced, arising from under hind surface of head; mandibles and maxillæ setaceous, enclosed in labium, which forms a jointed siphonal canal; body convex; tarsi not more than 3-jointed. Pupa active, semi-complete. Subsist upon vegetable juices which they pump up by means of their siphon-like mouth.

I. *SUB-ORDER.*—TRIMEROUS-HOMOPTERA (Trimera).

Tarsi 3-jointed; antennæ minute, setigerous; wings areolate.

1. FAMILY.—*Musical Harvest-Flies* (Cicadidæ). Antennæ 7-jointed, inserted between the eyes; head short, broad, transverse; eyes large, prominent; ocelli three, on back of head; proboscis greatly elongated, 3-jointed; fore-wings large, membranous, usually transparent, with few nervures; legs short, without spurs, not formed for leaping. Males possess musical powers.
2. FAMILY.—*Lantern-Flies* (Fulgoridæ). Antennæ 3-jointed; ocelli two, placed beneath eyes; head often dilated into hollow appendages varying in form and size; proboscis variable in length; wings usually thickly reticulated; legs generally fitted for leaping; spurs of hind feet large. Often secrete a white waxy product.
3. FAMILY.—*Leaping Harvest-Flies* (Cercopidæ). Antennæ 3-jointed, the last joint setiform, inserted between the eyes; ocelli two, on forehead or face; head rarely produced into a proboscis; prothorax variable in form and size; wings usually strongly veined; legs fitted for leaping, hind-tibiæ often spurred. Varied in colour; found among plants and on trees.

II. *SUB-ORDER.*—DIMEROUS-HOMOPTERA (Dimera).

Tarsi 2-jointed; antennæ moderate, filiform, 5—10-jointed; wings sub-areolate.

4. FAMILY. — *Blight-Flies* (Psyllidæ). Antennæ moderate, filiform, 10-jointed, inserted in front of eyes; head deeply cleft in front; eyes lateral, prominent; ocelli three, on top of head; proboscis short, 3-jointed; wings deflexed at sides of body, the fore-wings with three strong, furcate nerves; hind-legs fitted for leaping, with two strong spurs. Live upon plants; often produce galls.

5. FAMILY. — *Plant-Lice* (Aphididæ). Antennæ moderate, 7-jointed; head entire in front; eyes moderate; ocelli three, on top of head; proboscis long, perpendicular or inflexed; wings greatly deflexed in repose, the hinder with strong nerves; legs long and slender, formed only for walking. Females often apterous; body sometimes clothed with a white cottony secretion; live in society on various plants.

6. FAMILY. — *Mealy-winged Scale-Insects* (Aleyrodidæ). Antennæ short, 6-jointed; head small; eyes bipartite; proboscis short, 2-jointed; wings broad, oval, of equal size, covered with a white powder, nearly horizontal in repose, the anterior with only one strong central nerve; abdomen simple at tip; legs short, simple; larva scale-like. Both sexes with four wings in perfect state; feed on leaves of plants.

III. *SUB-ORDER.*—MONOMEROUS-HOMOPTERA (Monomera).

Tarsi 1-jointed; antennæ 6—25-jointed; wings not areolate.

7. FAMILY.—*Scale-Insects* (Coccidæ). Antennæ, in females, short, subsetaceous, inserted before eyes, in males, more or less elongated; mouth in females a short 3-jointed proboscis, in males obsolete; head in males, small, rounded; eyes composed of about ten grains, placed irregularly; ocelli none. Males winged; fore-wings large, horizontal in repose, hind-wings rudimentary; abdomen with two long anal setæ. Females apterous; body ovate, globose or shield-shaped, often densely clothed with a white downy or waxy secretion. Infect various plants, and do great damage; some species produce a valuable dye (cochineal).

BEE-PARASITES.

These singular little parasites are found, in the larval state, in the bodies of wasps and bees, and their oval white heads may frequently be observed protruding from between the rings of the abdomen in species of *Andrena* and other bees; in their imago condition they are short-lived, and fly with a vacillating motion, making a sort of humming noise. Their thorax is very long; their eyes are large and prominent; their antennæ are forked or branched;

their wings are large, opaque, and membranous; and there are two subspiral appendages at the base of the fore-legs. These insects have been placed by some between the Beetles and the Earwigs, while others have considered their natural position to be between the *Lepidoptera* and the *Diptera;* they are, indeed, often termed "Wasp-Flies," and "Wild-Bee Flies."

X. ORDER.—BEE-PARASITES (Strepsiptera).

Anterior wings in form of short, slender, contorted appendages; hind-wings very large, folding longitudinally, like a fan; mouth with two slender acute jaws wide apart, and two large 2-jointed palpi; tarsi 2–3 or 4-jointed. Larva apodal, vermiform, with a flattened head; pupa coarctate, inactive.

1. FAMILY.—*Bee-Parasites* (Stylopidæ). Antennæ of few joints, often furcate or branching, arising from between the eyes; head distinct, exposed; eyes large, lateral, prominent, upon the contracted sides of head; thorax very large; body long and narrow; wings opaque, membranous; legs moderate, weak, two anterior pairs with elongate coxæ; tarsal joints with fleshy cushions beneath, without terminal claws. Parasitic on bees and wasps.

FLIES.

Although not so numerous in species as some of the other Orders of Insects, with regard to individuals the Flies muster in very great force. They surround us, in some form or other, all the year throughout; and, during the hot weather the whole atmosphere seems filled with the humming sound of their wings. The Flies, in their perfect state, hover over flowers, and sip honey, like the Bees; but in their larval condition, their habits are very varied. Some among them prefer a vegetable diet, like the *Mycetophilæ*, which are found on fungi; some, like the *Syrphidæ*, feed upon the plant-lice, and help to keep those injurious hordes in wholesome check. The *Volucellæ* deposit their eggs in the nests of the Humble-Bees, that their young may take advantage of the food there stored up; others, as the Gad-Flies, lay their eggs in the skins of Ruminating animals, on which the larvæ subsist; while some devour putrescent bodies dissolved in water, as the Gnat and Mosquito. Some Flies are carnivorous and predatory in their perfect state, as the *Asilidæ*, which seize other insects, and suck their blood; others feed on decaying timber; others on bulbs, as the *Eristalis Narcissi* and the *Scatophaga Ceparum*. The pupiparous Forest-Flies nourish their offspring in a kind of marsupial pouch, and the Flesh-Flies lay their eggs on dead bodies, which their larvæ, when hatched, very soon consume.

XI. ORDER.—FLIES (Diptera).

Mouth suctorial, with a fleshy proboscis enclosing several lancet-like organs (formed by the tongue jaws and mandibles); labial palpi obsolete or none;

thorax compact, prothorax very short, fixed immovably to mesothorax; wings two, anterior membranous, not scaly, variously veined, with produced lobes or winglets at the base; hind-wings replaced by small clavate appendages or balancers; tarsi 5-jointed.

I. *SUB-ORDER.*—Proboscidean-Flies (Proboscidea).

Head distinct from thorax; legs close, side by side; claws of tarsi not dentate; larva not undergoing its metamorphosis within body of parent.

I. TRIBE.—Slender-horned Flies (Nemocera).

Antennæ composed of more than six joints; palpi 4 or 5-jointed; pupa incomplete.

1. Family.—*Leaping-Gnats* (Mycetophilidæ). Antennæ slender, 15 or 16-jointed, longer than head, compressed, never fasciculated; last joint of palpi not ringed; ocelli two or three, unequal; head not rostrate; coxæ elongated; hind-tibiæ spined, mostly with long spurs. Fungivorous; capable of leaping by means of their hind-legs.
2. Family.—*Gall-Gnats* (Cecidomyidæ). Antennæ more or less moniliform, of 13 joints, simply ornamented with a few verticillate hairs; eyes lunate; ocelli wanting; wings with few nerves, carried flat on the back, or roof-like, when at rest; legs long, not armed with spines. Deposit their eggs in leaves and stems; producing galls.

3. Family.—*Sand-Flies* (Bibionidæ). Antennæ seldom longer than head, thick, cylindric, moniliform or perfoliate; wings large; ocelli two or three; pronotum conspicuous; palpi 4-jointed; eyes, in males, large, contiguous. Found in marshy places; very troublesome to man and domestic animals.

4. Family. — *Black-Flies* (Simuliidæ). Antennæ seldom longer than head, cylindric or moniliform; ocelli none; wings and halteres large; costal vein ending near tip of wing; tibiæ and metatarsi broad, compressed. Found in damp marshy places; sometimes termed "Mosquitoes"; obnoxious to man and beast.

5. Family.—*Midges* (Chironomidæ). Antennæ slender, filiform, beset with long hairs forming in the males a large plume or brush, longer than head, basal joint very large; ocelli obsolete; eyes lunate, separate; body long and slender; legs very long, tibiæ simple, not armed with spines; often assemble in cloud-like swarms, and perform aerial dances.

6. Family.—*True-Gnats* (Culicidæ). Antennæ slender, filiform, plumose; basal joint sub-globose, tubercular; palpi very long, pilose at end; head small; mouth produced into a long slender rostrum; ocelli obsolete; eyes lunate; body long and slender; wings oblong, rounded at tip, incumbent, hind margins fringed with scales. Produce irritating bites; species constitute the true "Mosquitoes."

7. Family.—*Phlebotomists* (Phlebotomidæ). Antennæ slender, filiform, plumose in the males; head small; mouth rostrate; ocelli none; wings broad, ovate or lanceolate, deflected or divaricate; costal vein attenuated round hind margin, veins in their last divisions more than six. Troublesome blood-suckers.
8. Family.—*Moth-Gnats* (Psychodidæ). Antennæ elongate, composed of globular, verticillate joints; head small; wings oblong, rounded at tip, broad, deflexed, hairy, hind margin fringed with hairs. Small moth-like insects; often found on windows.
9. Family. — *Crane-Flies* (Tipulidæ). Antennæ longer than head, simple, not plumose, rarely pectinated; eyes entire, ocelli obsolete; front of head beaked; proboscis short, ending in two large fleshy lips; body elongated; wings long, nervures numerous; legs long. Found in damp meadows.
10. Family.—*False Crane-Flies* (Rhyphidæ). Antennæ longer than head, simple; eyes entire; ocelli two or three; wings and halteres large; body elongated; legs long; discal areolet complete.

II. TRIBE.—Short-horned Flies (Brachocera).

Antennæ shorter than head, terminal joints indistinctly articulated, or soldered together in a mass terminated by a seta; maxillæ and maxillary palpi usually distinct.

11. **Family.**—*Chameleon-Flies* (Stratiomidæ). Antennæ of six or seven joints, usually ending in a style or seta; organs of mouth rudimentary; scutellum often spined; body broad, depressed; wings incumbent when at rest; terminal veins very slender. Found upon flowers in watery situations.
12. **Family.**—*Tree-Flies* (Xylophagidæ). Antennæ 10-jointed, without any seta, the last joints forming a cylindric mass; scutellum unarmed; body narrow, cylindrical; wings parallel, incumbent or laid upon abdomen in repose. On trees.
13. **Family.**—*Breeze-Flies* (Tabanidæ). Antennæ with third joint large, remaining joints 3—7, closely united, tapering to the tip; proboscis exserted, enclosing lancets, and ending in two fleshy lobes; eyes large; scutellum large, elevated; abdomen triangular, depressed; wings extended horizontally, winglets large Pierce the skin and suck the blood of man and the lower animals.
14. **Family.**—*Humming-Bird Flies* (Bombyliidæ). Antennæ close together at base, often with a short terminal style; proboscis long, porrected in front of head; thorax much elevated; body short, thick, often clothed with hairs; wings horizontal, winglets small; legs very long and slender. Fly with great rapidity; hover over flowers without settling; make a humming noise with their wings.

15. FAMILY.—*Mottled-winged Flies* (Anthracidæ). Antennæ short, wide apart, ending in a pear-shaped joint, very slender at tip; proboscis short; head nearly spherical; thorax slightly elevated; abdomen somewhat square, often hairy; wings variously mottled and spotted; legs long, slender. Fly in sunshine with great agility.

16. FAMILY.—*Vesicular-Flies* (Acroceridæ). Antennæ minute, inserted close together; head minute, nearly all eye; thorax elevated; body round, inflated; wings deflexed, winglets very large, covering balancers, wings with the veins often indistinct. Slow-moving; found upon plants and among flowers.

17. FAMILY. — *Hornet-Flies* (Asilidæ). Antennæ with third joint clavate, ending in a 2-jointed seta; head transverse, depressed; eyes lateral; lower part of face bearded; proboscis moderate, porrect in front; thorax narrowed in front; body long, clothed with bristles; wings incumbent. Predacious; active in sunshine; make a humming noise.

18. FAMILY.—*Large-eyed Flies* (Hybotidæ). Proboscis short, horizontal; head small, globular; eyes occupying nearly its entire surface; clypeus slightly hirsute; thorax greatly elevated; abdomen narrow; wings with a discoidal post-medial cell; thighs of hind legs often thickened. Active; prey on other insects.

19. Family.—*Mydas-Flies* (Mydasidæ). Antennæ longer than head, 5-jointed, the two terminal ones large, forming a club; body elongated; wings with apical nerves running parallel with posterior margin; legs strong; tarsi with two brushes; hinder thighs thickened. Attack and devour other insects on the wing.

20. Family.—*Leaf-nosed Flies* (Therevidæ). Third joint of antennæ ovate-conic, ending in a small 3-jointed style; palpi enclosed in oral cavity; proboscis ending in a pair of large membranous labial lobes; wings divaricate, apical nervures running to extremity of wing; abdomen conical. Found on trees; often flying in swarms.

21. Family.—*Raptorial-Flies* (Tachydromiidæ). Antennæ apparently only 2-jointed, the basal being very minute; palpi incumbent, proboscis short; wings often with coloured bands, without any large cell beyond the middle; fore-legs elongate, thickened, spined, raptorial. Run very rapidly on trunks of trees; rapacious.

22. Family.—*Spur-legged Flies* (Leptidæ). Palpi large, external, filiform or conical; proboscis large, fleshy, ending in two elongate labial lobes; antennæ inserted near base of head, third joint round or reniform; wings divaricate, external nerve furcate; middle and hind-tibiæ with two apical spurs. Wings often spotted; frequent sunny sides of trees.

23. FAMILY.—*Flat-bodied Flies* (Scenopinidæ). Antennæ with the setæ wanting, terminal or dorsal; labium thick, ending in large lips; palpi long, thickened at tips; head hemispherical, almost entirely occupied by eyes in males; body flattened; wings with few veins; legs short. Colours obscure.

24. FAMILY.—*Predatory-Flies* (Empidæ). Antennæ as long as head, tapering to tips; head small, sub-globose; eyes large; proboscis elongate, perpendicular or folded beneath breast; palpi reflected, usually 2-jointed; body elongated; wings incumbent, large. Voracious, seizing on other insects and sucking their juices.

25. FAMILY.—*Water-loving Flies* (Dolichopidæ). Antennæ short, ending in a small oval or palette-shaped joint emitting a long seta; labium in females forming a conical muzzle; abdomen compressed, incurved at tip; wings incumbent when at rest; legs long, slender, armed with bristles. Metallic coloured; delight in frequenting the edges of water.

26. FAMILY.—*Marsh-Flies* (Lonchopteridæ). Proboscis distinct; cheeks bristly; eyes wide apart; wings pointed at tip, cubital vein simple, discal areolet wanting, axillary lobe obsolete. Frequent damp and marshy situations.

27. FAMILY.—*Wood-Flies* (Platypezidæ). Proboscis distinct; antennæ with last joints forming a slender arista attached to tip of third joint;

wings with axillary lobe rounded, cubital vein simple, brachial vein without a spurious vein. Inhabit damp woods.

28. Family.—*Hovering-Flies* (Pipunculidæ). Head large, hemispheric; eyes large; ocelli three, in a triangle on vertex; antennæ short, third joint compressed, deflexed, with a 3-jointed arista; proboscis very short; thorax globose; wings long, costal vein not continued round hind margin, cubital simple, axillary lobe rounded; abdomen cylindric or compressed. Inhabit woods and fields; often hover in the air.

29. Family.—*Aphis-eating Flies* (Syrphidæ). Antennæ with third joint dilated, emitting a seta, jointed at base, sometimes plumose; head hemispherical; eyes large; front of head beaked; proboscis long, membranous, elbowed near base, ending in two lobes, and enclosing four pieces; abdomen never incurved at tip; wings with perfect cells. Of variegated colours; fly with rapidity; hover in the sun.

30. Family.—*Parasitic-Bee Flies* (Conopidæ). Antennæ with short setæ either dorsal or terminal; palpi minute, without joints; proboscis long, always exserted, elbowed, siphon-shaped, enclosing two pieces; abdomen usually incurved at the extremity. Colour varied; frequenting plants and flowers.

31. Family. — *Flesh-Flies* (Muscidæ). Antennæ 3-jointed, the last with a dorsal seta or arista;

proboscis distinct, short, membranous, ending in two large labial lobes, entirely retractile, and enclosing only two pieces or setiform organs; body short, robust; abdomen not inflexed at end; wings and legs moderate. Feed on various substances both living and dead.

32. FAMILY.—*Gad-Flies* (Œstridæ). Antennæ very short, terminal joint rounded, emitting a seta; proboscis rudimentary or obsolete, consisting of two or three minute fleshy tubercles; wings divaricate, winglets very large, hiding the balancers, nervures few. Large hairy flies, often coloured in transverse bands; parasitic on different species of mammals. Larvæ termed "bots."

III. TRIBE.—HYPOCEROUS-FLIES (Hypocera).

Antennæ near epistome, with a single inconspicuous joint, and an arista; mandibles and maxillæ obsolete.

33. FAMILY.—*Phoridean-Flies* (Phoridæ). Palpi porrect, without joints; wings with anterior veins strong, costal ending about middle of rib, posterior very thin, simple, disunited; coxæ and femora thickened, compressed.

II. *SUB-ORDER.*—EPROBOSCIDEAN-FLIES (Eproboscidea).

Head immersed in thorax; claws denticulated; legs distant; larvæ nourished in body of parent until it has passed the pupa state.

34. **Family.**—*Spider-Flies* (Hippoboscidæ). Antennæ immersed in anterior angles of clypeus; head circular, closely united to thorax; eyes large; mouth covered with a membranous plate perforate at end, and with bristly narrow plates on sides, extended to form a kind of rostrum; body clothed with bristles, short, depressed, leathery; wings often rudimentary; head prone, the neck lying on prosternum. Parasitic; reside on birds and quadrupeds, running about the hairs and feathers with great agility.

35. **Family.**—*Bat-Lice* (Nycteribiidæ). Head turned back and upside down over mesonotum; antennæ very short, two-jointed; mouth with two large lateral setose valves, and a central style, enclosing several setæ; thorax flat; wings and balancers none, replaced by two comb-like organs; legs very long; claws strong, hooked. Parasitic on the bodies of bats.

FLEAS.

The insects forming this small Order, though deprived of wings, yet have a regular metamorphosis, and in their general structure, and especially of that of their mouth, closely approach the Order of Flies, with which indeed they are sometimes associated. They are remarkable for their extraordinary strength, sometimes ingeniously tested by making them draw miniature carriages, &c., and by the wonderful agility they display, often exciting the extreme wrath of him who desires to prevent them from enjoying a carousal off his blood. The common Flea (*Pulex irritans*) is produced from a small white polished egg; the larvæ are without feet, and beset with hairs, the head has short antennæ, and there is a pair of curved forks at the end of the tail. When the larva is full-grown, it casts its skin, becomes a grub or pupa; from which, in twelve days, the perfect insect emerges, with its sharp proboscis, and its shelly armour. Another troublesome insect belonging to this Order, is the Chigoe or Jigger (*Sarcopsylla penetrans*), a small black flea, which penetrates the flesh, and, if neglected, produces troublesome sores on the feet. A very large species of flea is found on the Mole; another species, of yet larger dimensions (*Pulex Echidnæ*), is found on the Australian-Porcupine; but perhaps the largest known is the *Pulex gigas*, from some northern animal.

XII. ORDER.—FLEAS (Aphaniptera).

Wings four, rudimentary, in form of small scaly plates on sides of body; antennæ minute, lying flat in cavities at sides of head; mouth formed for suction; mandibles and lingua setiform; body compressed; tarsi 5-jointed. Larva vermiform; pupa inactive, incomplete.

1. FAMILY—*Fleas* (Pulicidæ). Head small; mouth

a tubular beak formed of the labial palpi; mandibles elongate, flattened, serrated; body compressed, covered with a hard shining skin, clothed with rows of sharp bristles; segments continuous; fore-legs placed under the head; hind-legs formed for leaping; coxæ very large; tibiæ setose; tarsal claws double.

AIOLOPODS.

The Aiolopods comprise an extensive group of annulose animals which breathe like the Insects by means of tracheal tubes, but which undergo no regular metamorphosis; they are distinguished from the Arachnidans by the possession of a distinct head with two antennæ, and by the varied nature of their feet; like the Crustaceans they cast their skin, but are known at once from those animals by the absence of gills or respiratory feet. They are principally terrestrial in their habits, solitary, and usually of uninviting aspect.

The Myriapods are distinguished by the absence of a regular metamorphosis, and the large number of nearly equal-sized segments into which their bodies are divided. They comprise an assemblage of curious, though little known, animals, and are found in all parts of the globe. The best known among them are the Centipedes (*Scolopendra*), dreaded in tropical countries on account of their venomous bite. These Myriapods are easily known from others of their Order by means of their long flattened bodies. They are nocturnal in their habits, shunning the light, and usually concealing themselves under logs of wood, among loose stones, under the bark of decayed trees, or in the timbers of buildings. In hot climates they frequently attain to a formidable size, and their bite is then considered dangerous. They chiefly inhabit tropical countries, though a few small and harmless species occur in the southern parts of Europe, and one (*Lithobius forcipatus*) under damp moss, &c., in England. A few slender species are found to exhibit a vivid phosphorescent light. The hollow mandibles of the poisonous species end in a sharp hook, which is perforated at the point for the passage of the venomous fluid. The *Juli*, another group frequently observed, are at once distinguished from the Centipedes, by their long, slender body not being flat but cylindrical. These are perfectly harmless, and feed upon decaying vegetable matter. They are found in the loose earth, among moss, or under stones. Some of the large Asiatic species attain a length of six or seven inches. When they walk they move with a sort of undulating motion like a serpent, and when alarmed coil themselves up in a spiral form.

The Spring-tails, including the first part of the *Thysanura*, are usually found lurking under stones, or in the crevices of the bark of trees. By placing the elastic forked appendage of their tail under the body, and suddenly straightening it, they are enabled to leap and spring about. They feed on decaying animal and vegetable matter. The Sugar-lice, constituting the other section, are little active animals, covered with bright silvery scales. They are often seen running briskly about among old books and boards. They have simple eyes, like those of spiders, on each side of the head; and, in some respects, resemble Myriapods. Their antennæ are setaceous and elongated, and there are three setaceous appendages at the end of the tail.

The young Parasites differ from the parent only in size. Nearly every kind of quadruped and bird harbours species of these animals; and even in the human subject they have been known, by an excessive multiplication, perhaps induced by want of cleanliness, to have produced a loathsome disease, from which it is said Herod, Sylla, Antiochus, and Calisthenes perished. These pestiferous insects, including the Louse and its allies, have six feet formed for walking; their mouth is furnished with a suctorial proboscis; their antennæ are as long as the thorax; their abdomen is depressed and formed of several segments; and their mode of respiration is by tracheal tubes as in the insect races.

II. CLASS.—AIOLOPODS (Aiolopoda).

Animal breathing through stomata by means of respiratory tubes or tracheæ; apterous; head distinct, with two antennæ. Undergoing no regular metamorphosis, but casting their skin like Crustaceans.

I. ORDER.—MYRIAPODS (Myriapoda).

Eyes compound and granular; mandibles for cutting and bruising their food; no true jaws; sometimes two false labial palps; body elongated, formed of numerous rings, not divided into regions; feet more than six, often very numerous. Animals free.

I. *SUB-ORDER.*—CHILOPODS (Chilopoda).

Antennæ with four or more joints, tapering towards the extremity; lower lip double; segments flattened, each with one pair of feet.

1. FAMILY. — *Shielded - Centipedes* (Cermatiidæ). Body elongated, linear, depressed, with about eight imbricated coriaceous shield-like plates above, below divided into fifteen segments; antennæ setaceous, many-jointed, much longer than the head; mandibles two; palpi slender, exserted, spinulose; legs very long, slender, tarsi many-jointed.
2. FAMILY.—*Stone-Centipedes* (Lithobiidæ). Antennæ setaceous, a little longer than the head, seven or more jointed; mouth as in *Scolopendra*; body elongated, linear, depressed, equally divided above and below, the upper dorsal plates alternately larger and smaller; legs moderate.
3. FAMILY. — *True - Centipedes* (Scolopendridæ). Body elongated, linear, depressed, equally divided above and below; segments nume-

rous, sub-equal, not imbricate; legs numerous, moderate; antennæ subulate, a little longer than the head, joints short, fourteen or more; eyes two, distinct, granular; hind lip armed with two strong hooks forming a pincer.

4. Family.—*Earth-Centipedes* (Geophilidæ). Body very long and narrow; legs very numerous; antennæ composed of fourteen cylindrical joints, very slender towards the end; eyes not distinct; often electrical.

II. *SUB-ORDER.*—Chilognaths (Chilognatha).

Antennæ with seven joints, either equal throughout, or more or less thickened near the end; lower lip single, without curved hooks; segments of body annular, each with two pairs of legs.

5. Family. — *Woodlouse-Millipedes* (Glomeridæ). Body elongately oval, convex above, arcuate beneath, rolling up in a ball; segments eleven or twelve, semi-lunar, crustaceous, with a lateral scale, the last segment large, concave, semi-circular; feet 16—20; antennæ very short, sub-moniliform, 7-jointed, the sixth enveloping the last.

6. Family.—*Tufted-Millipedes* (Polyxenidæ). Body soft, elongated, depressed, furnished at the sides with tufts of piliform scales, the hind segment ending in a pencil of ciliated scales; antennæ very short, moniliform, inserted under the front margin of the head; palpi none.

7. Family.—*True-Millipedes* (Julidæ). Body elongate, cylindrical, smooth, crustaceous, rolling up spirally; segments formed of three imbricated parts with simple margins; antennæ short, sub-moniliform, a little thicker towards the tips, 7-jointed; mandibles two, horny, truncato-dentate at the apex; palpi none; lip flattened, with the upper margin crenate.

8. Family.—*False-Millipedes* (Polydesmidæ) Body depressed or sub-cylindric, rolling up spirally; segments formed of a single piece with dilated margins; antennæ slender; mouth as in *Julus*.

II. ORDER.—Fringe-Tails (Thysanura).

Eyes compound, granular; mandibles for dividing the food; sometimes jaws and distinct palpi; feet six, and other motive organs either on the sides of abdomen, or at its extremity. Free.

1. Family.—*Sugar-Lice* (Lepismatidæ). Antennæ many-jointed; palpi distinct, exserted; abdomen with moveable appendages on each side of lower part, and with jointed filaments at the extremity.

2. Family.—*Spring-Tails* (Poduridæ). Antennæ 4-jointed; no distinct palpi; abdomen without lateral scales, ending in a forked caudal appendage folded under the body when at rest.

III. ORDER.—Parasites (Anoplura).

Eyes smooth, simple; legs six; body not scaly;

abdomen not furnished with lateral or anal appendages; mouth with a retractile sucker, or in the form of a fissure with two hooked mandibles.

I. *SUB-ORDER.*—Suctorial-Parasites (Suctoria).

Mouth tubular, rostrate, enclosing an instrument for suction.

1. Family.—*Lice-proper* (Pediculidæ). Antennæ filiform, as long as the thorax; a single eye on each side; muzzle terminal, short, with a retractile sucker; tarsi of a single joint, ending in a folding hooked claw.

II. *SUB-ORDER.*—Jawed-Parasites (Mandibulata).

Mouth composed of two lips and two hooked mandibles,

2. Family.—*Bird-Lice* (Nirmidæ). Antennæ small, shorter than the head; eyes one or two on each side; mandibles two, hook-like; mouth inferior, sometimes a little below apex of head, sometimes sub-central, rimate, with two lips.

ARACHNIDANS.

Baron Walckenaer, the greatest authority on this class of animals, justly conceiving the intimate relation that must exist between the organization of these creatures and the webs they spin, has divided them into sedentary and wandering Spiders.

The first, or Sedentaries, are elongated, with slender legs, and construct large nets, in the middle of which they remain motionless, or retire to a side avenue to watch the unfortunates that fall into their snares. Some of these spin geometric webs, composed of concentric circles crossed by rays which unite in a common centre, and which are suspended vertically. The Spiders which construct these kinds of webs are of brilliant colours, and of singular forms, as *Epeira*, *Gasteracantha*, *Tetragnatha*, and *Uloborus;* others among them construct large irregular nets of threads crossing each other in all directions, these are formed by little but very industrious spinners, such as *Theridion* and *Episinus;* some, again, compose horizontal toils of a closely-woven fabric in the angles of walls and under stones, and furnished with a tubular passage formed of the same material, in which they lie and watch, such as *Tegenaria*, *Agelenar* and *Nyssus;* many again, form toils of compact meshes, suspended horizontally betweeen plants, but without any tubular passages, and with the webs more open and transparent, these cloth-weavers principally compose the genus *Linyphia*.

The Vagabonds, on the other hand, lead a wandering and desultory kind of life, and do not spin regular webs; some of them, however, throw out long single threads to entangle the feet of their victims, while they themselves watch vigilantly in the neighbourhood to take advantage,—such are the *Drassi*, the *Dysderæ*, and the *Dolomedes*. Others, of these Vagabonds, on the contrary, are hunting

Spiders, pass their days pleasantly in the chase, and often travel to considerable distances, such are the great powerful Bird-Spiders (*Mygale*), the Tarantulas, the Jumping-Spiders (*Attus*), and those that move with cautious sidelong pace, as *Thomisus* and *Sparassus*. In many tropical countries the threads of gigantic species of Spiders (*Nephila*) are sufficiently strong to entangle small birds, and even to prove troublesome to the passage of the traveller through the woods. These artful nets of "long-legged spinners" are, moreover, of different colours according to the nature of the weaver, being white, yellow, blue, and green; and in Mexico there is one composed of red, yellow, and black threads, interlaced with great and singular ingenuity.

Among other remarkable snares constructed by these daughters of Arachne may be mentioned that of the Trap-door Spiders, species of *Cteniza*, which bore galleries in the ground, coat the walls with mortar, line them with silk, and fit a door with a hinge, to the aperture; another curious application of their spinning powers is seen in the fabrication of the diving-bell of the Water-Spider (*Argyroneta aquatica*), which is an oval cocoon filled with air, lined with silk, and fastened by lines to plants under the water; one of the authors presented to the Linnæan Society the habitation of a Madagascar Spider composed of grains of quartz-sand united together by a fine web, forming a horn-shaped nest; these hung from the low shrubs that grow near the shore ride out in safety gales that would destroy ordinary webs.

The food of the Spiders being entirely insect, they are armed with powerful hollow jaws, which inject a poisonous fluid, by means of which they slay their victims when fairly entangled in their toils. Some, as the Jumping-Spiders, spring upon their prey like the Feline-Mammals ; others hunt it down like the Wolves and Dogs; while some again patiently await their victims in their artful nets, or lie motionless on the leaves and in the blossoms of plants ; others sit at the mouths of their subterranean tubes and keep a keen look out for stragglers, upon which they pounce, then kill and suck their blood. Some of the pedipalp Arachnidans, as the Scorpions, are provided with a powerful instrument of attack in the form of a sting at the end of their long jointed abdomen. As Typhon, or the Evil Spirit, the Scorpion figures as one of the signs of the Zodiac; some of the species which inhabit the hottest parts of Africa are often five or six inches in length, and produce highly venomous wounds; one, in fact, has received the generic name of *Androctonus* or Man-killer. These animals never spin webs but live on the ground, concealing themselves under stones; they feed on wood-lice, beetles, grasshoppers, and will devour also the eggs and larvæ of various Insects.

The Mites are found in various situations; some as the Cheese-Mite (*Acarus domesticus*) in our provisions; some, as the Ticks (*Ixodidæ*), fasten upon horses, cows, and dogs, and suck their blood; some are parasitic on birds and bats, and others on insects; the Water-Mites (*Hydrachnidæ*), live in the water; while others again are found crawling slowly about the leaves of various shrubs. One species, called the Red-Spider (*Gamasus telarius*), is a great pest to nurserymen and gardeners, producing much injury to plants in hot-houses; another well-known member of this tribe is the little Harvest-Bug (*Leptus autumnalis*), the bite of which occasions a painful irritation in those employed in the fields.

The Sea-Spiders form the connecting link between the Crustaceans and the Arachnidans; the *Pycnagonidæ* are parasitic upon Whales; the *Nymphonidæ*, harmless, inert, and slow-moving creatures, take up their abode among madrepores and branching corals.

III. CLASS.—ARACHNIDANS (Arachnida).

Head and thorax united, forming a cephalothorax; eyes simple; antennæ none; feet eight, formed for walking; no regular metamorphosis.

I. *SUB-CLASS.*—PULMONARY-ARACHNIDANS (Pulmonaria).

Respiration by means of pulmonary sacs; eyes 6—12.

I. ORDER.—SPIDERS (Araneidæ).

Palpi simple, pediform; mandibles armed with a moveable, perforated claw emitting a poisonous liquid; abdomen not jointed, terminating in spinnerets.

I. *SUB-ORDER.*—QUADRIPULMONARY-SPIDERS (Tetrapneumona).

Two pulmonary sacs and two spiracles on each side; legs robust.

1. FAMILY.—*Bird-Spiders* (Mygalidæ). Eyes eight; spinnerets four, two short and two prominent; hook or moveable claw of cheliceræ folded on the lower side, or that of the first joint, moving vertically.
2. FAMILY.—*Hunting-Spiders* (Dysderidæ). Eyes six in many; spinnerets six, very short; hook of cheliceræ folded transversely or along their inner side, moving laterally.

II. *SUB-ORDER.*—BIPULMONARY-SPIDERS (Dipneumona).

A single pulmonary sac and spiracle on each side of abdomen.

3. FAMILY—*True-Spiders* (Araneidæ). Hook of cheliceræ folded transversely or along their inner side, moving laterally.

1. GROUP.—*Sedentary Spiders* (Sedentaria). Eyes arranged transversely on front of cephalothorax; throw out threads for the capture of their prey, and station themselves upon or near their webs.

    1.—*Tapestry-Weavers* (Clubioninæ). Spinnerets cylindrical, placed together and directed backwards; legs robust; rectigrade.

2.—*Spinning-Spiders* (Theridioninæ). Spinnerets conical, slightly exserted, arranged in a rosette; legs slender; maxillæ narrow at tip, not dilated; rectigrade.

3.—*Geometric-Spiders* (Linyphinæ). Spinnerets conical, slightly exserted, arranged in a rosette; legs slender; maxillæ straight, widened at tip; rectigrade.

4.—*Crab-Spiders* (Thomisinæ). Fore-legs longer than the others; cheliceræ small; body depressed; abdomen broad, round or triangular; not making webs, but throwing out a few solitary threads; remain immovable, fixed upon the leaves of plants.

2. GROUP.—*Wandering-Spiders* (Errantia). Eyes arranged lengthwise on the cephalothorax; do not spin webs but wait for their prey, seize it running or leap upon it.

1.—*Wolf-Spiders* (Lycosinæ). Front row of eyes in a curvilinear series; thorax ovoid, narrowed in front, with a central longitudinal ridge; legs only fitted for running; maxillæ straight, rounded at tip.

2.—*Jumping-Spiders* (Salticinæ). Front row of eyes extending across the thorax in a straight line; thorax square, flat, not narrowed in front, sides deflexed; legs fitted for running and leaping.

II. ORDER.—PEDIPALPS (Padipalpi).

Palpi produced, cheliform or shaped like pincers; mandibles furnished with a moveable claw, not emitting a poisonous liquid; abdomen jointed, without spinnerets.

1. FAMILY.—*Scorpions* (Scorpionidæ). Stigmata eight, situated along lower and lateral part of abdomen; mandibles chelate or ending in two digits, the outer of which is moveable; comb-like organs on inferior part of thorax.
2. FAMILY. — *Tarentulas* (Phrynidæ). Stigmata four, situated near origin of abdomen; mandibles unguiculate or ending in a moveable claw; thoracic combs none.

II. *SUB-CLASS.*—TRACHEARY-ARACHNIDANS (Trachearia).

Respiration by means of ramifying tracheal tubes; eyes two or four, smooth.

I. ORDER.—SIMPLE-TRACHEARIANS (Monomerosomata).

Body without division, the head, trunk, and abdomen being united into a single mass; abdomen not annulated.

I. *SUB-ORDER.*—MITES (Errantia).

Mouth with distinct mandibles; palpi always present. Animals free.

1. FAMILY.—*True-Mites* (Acaridæ). Palpi slightly developed, adherent to the lip; mandibles

cheliform; eyes none; legs for walking, tarsi ending in a vesicle.

2. FAMILY. — *Garden-Mites* (Trombiidæ). Palpi pointed, with a moveable appendage below the tip; feet formed for walking; eyes latero-anterior; cheliceræ ending in a moveable claw.

3 FAMILY.—*Spider-Mites* (Gamasidæ). Palpi filiform, incurved, short, free; mouth with two didactyle cheliceræ; body depressed, skin soft or scaly; legs formed for walking, tarsi unguiculate.

4. FAMILY.—*Wood-Mites* (Orbitidæ). Palpi fusiform, hid under the head, without hooks; mouth with didactyle cheliceræ; eyes not distinct; body hairy or scaly, produced and rostrate in front; legs formed for walking.

II. *SUB-ORDER.*—TICKS (Suctoria).

Mouth in form of a sucker, with or without palpi; no apparent mandibles. Animal attached.

5. FAMILY.—*True-Ticks* (Ixodidæ). Palpi valviform, enclosing the sucker; mandibles 3-jointed, the last joint scale-like and denticulate; cheliceræ none; eyes none; legs formed for walking.

6. FAMILY.—*Plant-Ticks* (Bdellidæ). Palpi antenniform; mandibles unguiculate or cheliform; eyes distinct; sucker in form of elongated beak; body with a corselet; legs formed for walking.

7. FAMILY. — *Water-Ticks* (Hydrachnidæ). Palpi with the last joint armed with points, the third and fourth joints larger than the others; body simple, oval or rounded; eyes supero-anterior; legs ciliated, formed for swimming; parasitic in the young state. Aquatic.

8. FAMILY.—*Harvest-Ticks* (Leptidæ). Palpi short; sucker porrected; body depressed, coriaceous, ovately rotund; legs six, two being undeveloped.

II. ORDER.—JOINTED-TRACHEARIANS (Adelarthrosomata).

Body divided into three or four distinct segments; abdomen distinct, annulated; mouth with conspicuous didactyle pincers or chelicerae.

1. FAMIY.—*False-Scorpions* (Solpugidæ). Mandibles in the form of large compressed claws, with a moveable finger; palpi large, in the form of feet or of cheliferous arms; body oblong, soft; abdomen hairy.

2. FAMIY. — *Book-Scorpions* (Cheliferidæ). Mandibles short, didactyle at the ends; palpi very large, arm-like, with a pincer at the end; body ovate, depressed, narrowed in front; legs of equal size, short, ending in two hooks.

3. FAMILY.—*Shepherd-Spiders* (Phalangidæ). Mandibles very conspicuous, composed of two or three pieces, free, ending in a didactyle pincer; palpi filiform, ending in a hook; body

short, rounded; abdomen segmented; legs elongated.

III. *SUB-CLASS.*—APOROBRANCHIATE-ARACHNIDANS (Aporobranchiata).

Body linear, divided into four distinct segments; spiracles none; feet eight, for locomotion,—in the females two false feet for carrying the eggs; eyes four, smooth, situated on a tubercle.

1. FAMILY.—*True Sea-Spiders* (Nymphonidæ). Body small, elongated; palpi filiform, furnished with a hooked claw at the end; legs very long. Free.
2. FAMILY.—*Parasitic Sea-Spiders* (Pycnogonidæ). Antennæ and palpi obsolete; legs short and robust. Parasitic on Whales.

CRUSTACEANS.

These annulose animals differ from the insects in their respiration being performed by means of gills; their circulation is double, the blood passing through the gills as well as through the body generally; their nervous system forms two ganglionic chains, as in other *Annulosa;* they have no wings; and some of their legs are modified to serve as organs of prehension around the mouth. In the Decapods the fore-legs are transformed into arms, with a prehensile pincer at the end, composed of a finger and a moveable thumb, by the help of which strong calcareous hands they are enabled to crack the shells of mollusks and convey the food to their mouths. In some, as the Mantis-Crabs, these claws are long and prehensile, the moveable thumb being folded in a groove of the tibia. In numerous instances the Crustaceans seem to be the marine representatives of the Insects of the land, the sessile-eyed tribes corresponding to the Myriapods, and the peduncle-eyed families to the Arachnidans; the names of others suggest similar analogies, as Spider-Crabs, Scorpion-Crabs, Mantis-Crabs, &c.

The habits of these animals are extremely varied: thus we find some living on the land, as the *Gecarcini;* others inhabiting sandy places near the sea, as the Horseman-Crabs, which run very fast, and form deep burrows; others, also living in holes in similar situations, like the *Gelasimi*, hold up and snap their great disproportioned claw, appearing to beckon with one hand, and hence have been termed Calling-Crabs. The Hermit-Crabs are true pirates, seizing upon the shells of various mollusks, and using them as houses for themselves, their abdomens being soft and spiral to adapt them to such a mode of life. The *Cœnobitæ*, which live in wide-mouthed shells, have one claw very large to serve as an operculum; but the *Paguri*, which inhabit shells with narrow mouths, have both claws equal. Another genus of this family has the abdomen hard, and lives in holes of the mountains; this, which is the Tree-Lobster (*Birgus latro*), ascends the Palms and devours the fruit, and is in turn pursued by the Climbing-Perch (*Anabas testudineus*); thus we have both Crabs and Fishes climbing up terrestrial Palm-trees. Some Crustaceans attain a large size when compared with the Insect tribes, the Thorny-Lobster (*Palinurus vulgaris*) being sometimes nearly three feet in length. The common Lobster (*Astacus gammarus*) is an especial favourite among epicures, and is easily recognized by its enormous claws. The tribes of *Crustacea* change their skins or moult regularly, while among insects this takes place only in the larval state; but in these animals, which continue to grow all their lives, the changing of their coats occurs at regular intervals. They have the singular power, moreover, of replacing a lost or mutilated limb by growing another, which reconciles them to parting with their legs when seized by their enemies. Some among them are enabled to leap about, like the Sand-hoppers (*Gammaridæ*), while the extinct tribe of Trilobites possessed the faculty of rolling themselves up in a ball like the Wood-lice of the present epoch. The members of the great Entomostracous group, which are covered with a thin horny skin, are extremely varied in their external form; some have suctorial mouths, and live parasitic on other animals; others masticate their food by means of horny jaws; while some, as the King-Crabs, employ the dilated coxæ of the six anterior pairs of legs for the same purpose; thus these animals may be said to eat with their legs. Some of them, as the *Cypris*, are enclosed in a bivalve shell, and represent the *Mollusca;* others, again, approximate the Arachnidans, as the

King-Crabs, in which the head is united to the thorax; while others show an affinity with the Cirrhopods, as the Water-Fleas, which have their bodies enclosed between shell-like plates, and produce currents of water by means of vibratile feet. The *Branchipi*, as their name implies, breathe by means of their legs, and inhabit stagnant water. The Xiphosurans have a long and spine-like tail, and all their legs are furnished with pincers, by means of which the food is conveyed to the maxillary legs; these crustaceans form the symbol among the Japanese for the zodiacal sign "Cancer."

Whatever region is visited by the Carcinologist, there will he find objects for his study and consideration. The northern shores, although numerous in individuals, harbour but a small number of species, among which the curious Amphipods, the Sea-Centipedes (*Idotea*), the Stone-Crabs (*Lithodes*), the Spiny-Shrimps (*Hippolyte*), the Shrimps-proper (*Crangon*), besides the odd-shaped *Caprella* and *Cuma*, will reward his research. Some of these forms remain on the sands, and among the rocks, at great depths in the sea; others are found in muddy shallows near the shore.

In all seas, among the gulf-weed, the Sailor-Crab (*Nautilograpsus*) will be met with, that same crab, which in a critical moment, served Columbus just before he discovered the New World; in the dense masses of floating sea-weed he will also find *Amphoroidæ*, *Sphæromata*, *Cassidinæ*, &c., spinning and darting about, or crawling on the stems of the *Sargassa*.

On the coast of the Scandinavian countries he will encounter the Norway-Lobster (*Nephrops*), the Spider-Crabs (*Oxyrhynchi*), the Common-Lobsters (*Homari*), and many members of the Crabs-proper (*Canceridæ*). Some of these remain habitually on the sands and among the rocks, at great depths, and must be dredged; some spend their days altogether on shore, living in burrows and holes, or under stones and sea-weed.

On the shores of France and England, the *Carcinus mænas*, or Common-Crab, the large Edible-Crab (*Cancer Pagurus*), the Hermit-Crabs (*Paguri*), the Cray-Fish (*Astaci*), the Prawns (*Palæmon*), and the Spiny-Crabs (*Maia*, *Pisa*, &c.), will all be met with; but the Crustaceous Class, besides the Crabs, Prawns, and Lobsters, comprises many curious forms, which, if not equally as savoury, are yet well worthy of the traveller's attention; their habits especially require much investigation, their modes of changing their skin, reproducing lost limbs, and luminous properties, also demand his consideration.

In the Mediterranean, the collector of Crustaceans will first meet with the Swimming-Crab (*Lupa*), and in bottoms covered with weeds and coral, *Mithrax* and *Acanthonyx;* and hiding and shuffling under stones, *Trapeziæ*, and the Porcellanous-Crabs: here also he will see, for the first time, *Calappa*, or the Crested-Crab, feigning death on the moist loose sands; and also the Sea-Locusts (*Scyllari*), and the Sea-Mantises (*Squillæ*), in shallow, weedy, and sandy bottoms, darting rapidly above the surface in straight lines, leaving turbid tracks, or in shallow bays, springing backwards through the water.

In Chili and Patagonia, the Horseman-Crabs (*Ocypodæ*) will be found, coursing along the sands in a sidelong manner, and rapidly disappearing in holes of the sand when *almost* caught. Many other interesting genera will also here be met with, as *Hepatus*, *Leucippe*, *Epialtus*, *Eurypodius*, *Atelecyclus*, *Platycarcinus*, and *Grapsus* or the Painted-Crabs, which, active, bold, and predaceous, will be seen running over the rocks near the sea.

If he visit the shores of Madagascar, our traveller-Carcinologist must look for *Menæthius*, *Xantho*, *Ranina*, *Ixa*, besides the Horseman and Calling-Crabs, *Calappa*, *Pisa*, and others; and the same forms will be met with at the Cape of Good Hope, in the Isle of France, and at the Seychelles.

In India and New Guinea, the Decapodous *Egeria*, *Doclea*, *Pericera*, and *Varuna*, and the Swimming-Crabs, *Thalamita*, *Lupa*, *Pseudocarcinus*, and *Matuta*, must be hunted; on gravelly floors, and on submerged beds of broken shells, the Long-armed *Lambri* must be sought for; under stones, turned on the beach at low water, *Alope* and *Alpheus*, snapping loudly the pincers of their fore-legs, will be discovered; the fresh-water *Sesarmæ* frequenting the running brooks; the Telescope-eyed Crab (*Macrophthalmus*) burrowing in the sand; the Mountain-Pirate (*Birgus*) inhabiting holes in the hills;

the China Crabs (*Leucosiidæ*) in the sandy bays; and when the tide leaves the mud banks, Calling-Crabs (*Gelasimi*) coming out of their burrows in dense crowds; and the *Gebiæ*, or Mud-Bores, perforating the flats at the mouths of rivers, must all be noticed, and if possible captured.

In the Japan and China Seas many curious genera, not before seen, will be encountered, as *Oeidia*, *Acanthodes*, *Curtonotus*, *Berenia*, and *Eriocheir;* in New Zealand, and along the shores of New Holland, will be found *Naxia*, *Pseudocarcinus*, *Xantho*, and *Portunus.* In fact, whether they are "good for the pot," as the larger species; whether they are parasites, on whales and fishes, as the *Cymothoidæ;* whether they chew their food by teeth in their stomach, as the *Canceridæ*, or masticate it by the bases of their hips, as the *Limulidæ;* whether they breathe by gills, as the *Podophthalmi*, or by their legs, as the *Amphipoda;* whether they have long telescope-eyes, as the *Macrophthalmus*, or a single large eye, as in *Cyclopidæ*, they are all equally remarkable animals, and, as such, deserving of especial observation.

IV. CLASS.—CRUSTACEANS (Crustacea).

Animal articulated, covered with a horny or calcareous skin; legs jointed; head furnished with antennæ and jaws; respiration aquatic, by gills; blood colourless, in distinct vessels; sexes distinct.

I. LEGION.—PEDUNCLE-EYED CRUSTACEANS (Podophthalmata).

Animal with gills properly so called; eyes on moveable peduncles; rings of thorax covered by a carapace.

I. ORDER.—Decapods (Decapoda).

Five pairs of ambulatory legs; gills at their base, under the thorax; mouth with five pairs of feet-like jaws; head covered by the thorax.

1. *SUB-ORDER.*—Short-tailed Decapods (Brachyura).

Abdomen slightly developed, not serving for natation, folded under body, without appendages.

1. Family. — *Spider-Crabs* (Inachidæ). Carapace triangular, beaked in front; fore-legs short, slender, second and third pairs very long; third joint of outer foot-jaws not bearing the next joint at its anterior and inner angle.
2. Family.—*Spiny-Crabs* (Maiidæ). Carapace spiny, sub-triangular, with two horns in front; fore-legs longer and thicker than second pair; third joint of outer foot-jaws with the fourth joint on its anterior and inner angle.
3. Family. — *Long-armed Crabs* (Parthenopidæ). Carapace triangular, tubercular, entire or simply grooved in front; fore-legs greatly developed, hand triangular, pincers recurved, other legs short.
4. Family. — *True-Crabs* (Canceridæ). Carapace convex, rounded at margins; fore-legs usually very large and prehensile, ending in strong pincers, the others short and ambulatory; third joint of outer foot-jaws quadrilateral, not truncate at its front inner angle.

5. FAMILY.—*Swimming-Crabs* (Portunidæ). Carapace trapeziform, slightly elevated; fore-legs very long and spiny, hind legs natatory, with flattened tarsi; third joint of outer foot-jaws strongly truncate at its front outer angle.
6. FAMILY.—*Freshwater-Crabs* (Thelphusidæ). Carapace wider than long, straight anteriorly; eye-peduncles thick, short; fourth joint of outer foot-jaws never inserted at outer angle of the preceding joint; fore-legs strong, longer than the others.
7. FAMILY.—*Land-Crabs* (Gecarcinidæ). Carapace transversely oval, rounded and tumid at the sides, front wide, recurved; eye-peduncles moderate; fourth joint of outer foot-jaws inserted at outer angle of the preceding joint; fore-legs long and stout; lining membrane of gill-cavity spongy.
8. FAMILY.—*Pea-Crabs* (Pinnotheridæ). Carapace soft, circular, front very narrow; eyes small; fourth joint of external foot-jaws inserted at outer angle of the third joint.
9. FAMILY.—*Sand-Crabs* (Myctiridæ). Carapace thin, flattened, or globular, front narrow, strongly inclined; eyes small, short, not folding in the orbits; inner antennæ small; outer foot-jaws long and narrow, or vertical and forming a cone-shaped cavity.
10. FAMILY.—*Horseman-Crabs* (Ocypodidæ). Carapace quadrilateral or rhomboidal; eye-pedun-

cles usually very long, with the cornea produced; front narrow, recurved; fourth joint of outer foot-jaws inserted on the external angle of the preceding joint.

11. FAMILY.—*Angular-Crabs* (Gonoplacidæ). Carapace transversely quadrilateral; eye-peduncles usually very long, cornea small; front very wide; fourth joint of outer foot-jaws inserted in a groove of front inner angle of the third joint.

12. FAMILY.—*Painted-Crabs* (Grapsidæ). Carapace sub-quadrilateral, depressed; eye-peduncles very short and thick; front very wide, strongly recurved; fourth joint of outer foot-jaws inserted at the middle of the anterior margin, or at the outer angle of the third joint; fore-legs usually short, hind-legs compressed.

13. FAMILY.—*Crested-Crabs* (Calappidæ). Carapace subcircular, gibbous, the front moderate, edges thin or denticulate; external antennæ small; fore-legs strong, compressed, and elevated above into crests.

14. FAMILY.—*China-Crabs* (Leucosiidæ). Carapace usually circular, porcellanous; produced anteriorly with front and orbits at the end; no branchial apertures before base of fore-legs.

15. FAMILY.—*Globular-Crabs* (Corystidæ). Carapace more or less globular, usually rough; gill openings before base of fore-legs; exter-

nal antennæ very large; hind-legs ambulatory, the same as the others.

16. FAMILY.—*Shielded-Crabs* (Dorippidæ). Carapace depressed, quadrilateral, short behind, often protected by shields of foreign bodies; external antennæ very large; fore-legs short, hind-legs very short, not ambulatory, placed above the others, and serving to secure the adventitious shields.

II. *SUB-ORDER.*—VARIED-TAILED DECAPODS (Anomoura.)

Abdomen slightly developed, not serving for natation, sometimes folded under the body, sometimes extended, bearing appendages more or less developed.

17. FAMILY.—*Sponge-Crabs* (Dromiidæ). Body globular, front strongly recurved; eyes short; outer foot-jaws enlarged, and operculiform; legs short and stout, fore-legs ending in strong pincers, fifth pair raised above the others on the sides of the carapace, and ending in a hook.

18. FAMILY.—*Stone-Crabs* (Homolidæ). Carapace spiny, beaked in front; internal antennæ exposed; foot-jaws pediform; legs long, fifth pair very short, not ambulatory.

19. FAMILY. — *Frog-Crabs* (Raninidæ). Carapace ovate, narrowed in front; eye-peduncles composed of three moveable pieces; internal antennæ exposed; outer foot-jaws elongated, not pediform; fore-legs strongly compressed

hind-legs flattened, ending in a large lamellate joint for natation.

20. Family.—*False Frog-Crabs* (Hippidæ) Carapace transversely oval, convex, prolonged on each side into a lamella which covers bases of legs; antennæ very long; foot-jaws with last joint very much developed; fore-legs monodactyle or sub-cheliform, hind-legs ending in a lamellar joint for digging in the sand, fifth pair filiform.

21. Family.—*Hermit-Crabs* (Paguridæ). Carapace triangular; outer antennæ with a spiniform piece below second joint; outer foot-jaws pediform; fore-legs unequal, ending in a large hand with short strong pincers, fourth pair of legs short, didactyle, raised above the others, fifth pair very short, on the sides of the body, ending in a pincer more or less well-formed; abdomen soft, usually protected by an adventitious shell.

22. Family.—*Lobster-Crabs* (Porcellanidæ). Carapace sub-circular, depressed, front produced below insertion of inner antennæ; eyes small; outer antennæ very long; outer foot-jaws very large, their second joint with a lamellar dilatation on the inner side; fore-legs large and flattened, hind-pair slender and didactyle; abdomen large, ending in a laminated fin.

III. *SUB-ORDER.*—Long-Tailed Decapods (Macroura).

Abdomen greatly developed, serving for natation, extended posteriorly, bearing false feet, and ending in a caudal fin.

23. Family.—*Plaited-Lobsters* (Galatheidæ). Carapace oblong, depressed, front beaked; outer foot-jaws pediform; fore-legs large, ending in a well-developed pincer, fifth pair very slender, folded below the others in the branchial cavity; abdomen longer than thorax; caudal fin large and lamellar.

24. Family.—*Locust-Lobsters* (Scyllaridæ). Carapace very large, slightly elevated, straight in front, with a horizontal prolongation between the bases of the outer antennæ; outer antennæ foliaceous and very large; foot-jaws moderate, sub-pediform; fore-legs ending in a styliform tarsus, hind-legs of female ending in a small incomplete pincer; abdomen very large.

25. Family.—*Thorny-Lobsters* (Palinuridæ). Carapace convex, longitudinal, front with two large horns; eyes large, short, rounded; inner antennæ very long; outer antennæ very thick and long, basal joints spiny; outer foot-jaws small, pediform; mandibles very thick, with cutting edges; legs all monodactyle, fore-legs the shortest; abdomen very large and long.

26. Family.—*Scorpion-Lobsters* (Thalassinidæ). Carapace small, laterally compressed, shortly beaked in front; eyes small; external antennæ with a small moveable spine at base;

fore-legs large, more or less completely didactyle, the others elevated on each side of thorax; abdomen narrow; body rather soft.

27. FAMILY.—*True-Lobsters* (Astacidæ). Carapace elongated, beaked in front; outer antennæ with a moveable lamina at their base; outer foot-jaws elongated; fore-legs very large, ending in thick didactyle pincers, second and third pair with a small pincer, the others monodactyle.

28. FAMILY. — *Prawns* (Crangonidæ). Carapace rather depressed, slightly beaked in front; eyes short, thick, free; mandibles slender, without palpi; outer foot-jaws pediform; fore-legs ending in a flattened monodactyle hand, with the finger rudimentary, second pair with very small pincers, hind-legs strong, monodactyle.

29. FAMILY.—*Clicking-Shrimps* (Alpheidæ). Carapace rather compressed, shortly beaked in front; one pair of legs very large, and in general ending in a strong didactyle hand, two pairs of anterior legs didactyle, third pair monodactyle, hind-legs robust, for swimming or walking.

30. FAMILY.—*Shrimps-Proper* (Palæmonidæ). Body laterally compressed; carapace with a large pointed serrated beak in front; first pair of antennæ often with three terminal filaments; legs all slender, the two first pair in general didactyle, the three last monodactyle.

31. **Family.**—*Penæan-Shrimps* (Penæidæ). Abdomen extremely elongated; legs often with a palpiform appendage at their base; beak short or wanting; antennæ very long; legs long and slender for swimming, last pair rudimentary or wanting.

32. **Family.**—*Horned-Shrimps* (Cerataspidæ). Carapace large, sub-ovoid, tumid at the sides, surface tubercled, prolonged inferiorly so as to conceal the legs and antennæ, leaving a longitudinal fissure, armed with five horns, one forming the beak, two on the sides in front, and two behind these; legs long and slender with a lateral appendage; abdomen narrow.

II. ORDER.—Stomapods (Stomapoda).

Gills external, on the abdomen; head horny, separated from the thorax; mouth with three pairs of jaws; legs seven pairs, prehensile or for swimming.

1. **Family.**—*Opossum-Shrimps* (Mysidæ). Carapace slightly beaked in front; mandibles with a palpiform appendage on upper and lower lip, and two lamellar jaws; foot-jaws, each with two well-developed branches at their base; abdomen moderate.

2. **Family.**—*Spectre-Crabs* (Phyllosomatidæ). Animal transparent; carapace large, lamellar, horizontal; thorax lamellar; eyes large and prominent; mouth with a large upper jaw, a pair of hooked mandibles, a membranous

bilobed lower lip, and a pair of jaws; foot-jaws rudimentary; legs seven or eight pairs, first short, the others long and slender; abdomen narrow, rudimentary.

3. FAMILY.—*Glass-Shrimps* (Erichthidæ). Gills rudimentary; carapace large, lamellar, transparent, with a styliform beak in front; first two joints of head moveable, second joint of outer antennæ with an oval lamina with ciliated margins; upper lip triangular; mandibles with two branches with dentate margins; abdomen elongated, last segment very large.

4. FAMILY.—*Mantis-Crabs* (Squillidæ). Carapace leaving uncovered the first two rings of head and last four of thorax; thorax sub-quadrilateral, with a small moveable triangular plate in front; mandibles ending in two divergent branches, with dentate margins; lower lip deeply bilobed; second pair of jaws long, and pediform, anterior foot-jaws largely developed in the form of raptorial feet folded thrice on themselves, and resembling the fore-legs of the "Mantis"; abdomen very large.

II. LEGION.—SESSILE-EYED CRUSTACEANS (Edriophthalmata).

Gills replaced by portions of the legs modified for that purpose. Body divided into head, thorax, and abdomen; no carapace; eyes sessile.

I. ORDER.—Amphipods (Amphipoda).

Palpi of the thoracic extremities vesicular and subserving respiration; abdomen greatly developed, serving for locomotion; six pairs of legs, the three first differing in form and use from the three last.

1. Family. — *Sandhoppers* (Gammaridæ). Head small; fore-legs developed for digging; foot-jaws very large, covering the entire mouth, ending in four large horny laminæ, and two very long jointed palpiform appendages.
2. Family.—*Hyperians* (Hyperiidæ). Head large; thoracic legs often prehensile; abdomen ending in a swimming fin; foot-jaws moderate, ending in three horny laminæ without any palpiform appendages.

II. ORDER.—Læmodipods (Læmodipoda).

Palpi of thoracic extremities vescicular, and subserving respiration; abdomen rudimentary, in the form of a small tubercle.

1. Family.—*Skeleton-Shrimps* (Caprellidæ). Body elongated, cylindrical, narrow; four well-developed antennæ; legs long and slender, fore-legs inserted near mouth, ending in an oval hand.
2. Family. — *Whale-Fleas* (Cyamidæ). Body depressed, oval; head small, second pair of antennæ very small; legs short, curved, prehensile; fore-legs inserted under the head, ending in a small sub-cheliform hand.

III. ORDER.—Isopods (Isopoda).

Palpi of thoracic extremities not vesicular; abdomen well-developed; five first pairs of abdominal extremities lamellar, and subserving respiration.

I. *SUB-ORDER.*—AMBULATORY-ISOPODS (Ambulatoria).

Mouth with two pairs of jaws besides mandibles and foot-jaws; hind false-feet styliform or opercular, not forming a caudal fin.

1. FAMILY.—*Sea-Centipedes* (Idoteidæ). Body linear, elongated; terminal appendages of hind false-feet large, lamellar, opercular, covering all lower surface of abdomen; not prolonged beyond the last segment, which is scutiform and very large.
2. FAMILY.—*Sea-Woodlice* (Asellidæ). Body more or less elongated; terminal appendages of hind false-feet styliform and prolonged beyond abdomen like a tail; last joint of abdomen very large, scutiform; internal antennæ small but distinct.
3. FAMILY.—*Fork-tailed Sea-Woodlice* (Lygiidæ). Body oval, head small; terminal appendages of hind false-feet styliform, slender, elongated, completely exposed, and ending in two styliform appendages; last joint of abdomen very small, not scutiform; internal antennæ rudimentary.
4. FAMILY.—*Woodlice-proper* (Oniscidæ). Body oval, convex; terminal appendages of hind false-feet short, not extending beyond last segment of abdomen, last joint of abdomen very small, not scutiform; internal antennæ rudimentary.

II. *SUB-ORDER.*—Natatory-Isopods (Natatoria).

Mouth with two pairs of jaws besides mandibles and foot-jaws; hind false-feet ending in horizontal laminæ, which form with the last segment of the abdomen, a caudal fin.

5. Family.—*Pranisians* (Pranizidæ). Head united to the first two thoracic rings; antennæ setaceous; thorax composed of five rings; the two first pairs of legs rudimentary or wanting, five last pairs of legs slender, ambulatory; abdomen narrow, but greatly developed.
6. Family. —*Sphæromids* (Sphæromatidæ). Body oval, convex; thorax of seven moveable rings; seven pairs of legs nearly equal; abdomen short; foot-jaws palpiform; first five rings of abdomen soldered together, hind false-feet ending in two lamellar appendages, the outer one only moveable; head large; legs simply ambulatory.
7. Family.—*Fish-Lice* (Cymothoidæ). Body oval; head small; thorax of seven moveable rings; seven pairs of legs, nearly equal; abdomen very short; foot-jaws opercular; first five segments of abdomen not soldered together, last false-feet ending in two moveable laminæ; legs short and hooked. Parasitic on fish.

III. *SUB-ORDER.*—Sedentary-Isopods (Sedentaria).

Mouth without jaws, but with distinct mandibles and foot-jaws; hind false-feet replaced by two membranous filaments, not jointed.

8. Family.—*Tailed Crab-Lice* (Ionidæ). Body narrow, elongated; head large; outer antennæ styliform; abdominal appendages filiform, and extending beyond abdomen; legs all ending in sub-cheliform hands. Parasitic on *Callianassa*.

9. Family.—*Tail-less Crab-Lice* (Bopyridæ). Body pyriform, depressed; head inserted, rounded in front; antennæ rudimentary; abdominal appendages lamellar, and concealed under abdomen.

III. LEGION.—Branchiopods (Branchiopoda).

Mouth with organs of mastication; no gills properly so called; thoracic members foliaceous, membranous, subservient to respiration.

I. ORDER.—Phyllopods (Phyllopoda).

Body naked, covered with a carapace, or enclosed in a bivalve test; legs, eight pairs, simple, natatory, the rest foliaceous.

1. Family.—*Nebalias* (Nebaliidæ). Body enclosed in a bivalve test; carapace beaked in front; eyes peduncled; antennæ large, forming natatory oars; four pairs of natatory non-branchial feet, the rest branchial.

2. Family.—*Apuses* (Apodidæ). Carapace bivalve or scutiform; all the feet branchial, consisting

of more than eighteen pairs; abdomen narrow, cylindrical.

3. FAMILY.—*Pond-Shrimps* (Branchipidæ). Body elongated, without a bivalve or scutiform carapace; eyes pedunculated; nine pairs of branchial feet.

II. ORDER.—LOPHYROPODS (Lophyropoda).

Body enclosed between two valves; feet four or five pairs, foliaceous.

1. FAMILY.—*Water-Fleas* (Daphniidæ). Head distinct, prominent, prolonged below into a beak; a single eye on anterior part; upper antennæ in the form of large oars; abdomen conical.
2. FAMILY.—*Polyphemuses* (Polyphemidæ). Head very large, nearly all occupied by a single great eye; upper antennæ very large, ending in two branches with long hairs; feet four pairs; abdomen recurved, not lodged in valves of carapace.
3. FAMILY.—*Beaked Water-Fleas* (Lynceidæ). Head small, curved below in form of a beak and prolonged posteriorly over back; a single eye; antennæ short; valves of carapace very large.

IV. LEGION.—ENTOMOSTRACANS (Entomostraca).

Gills none; eyes sessile; mandibles adapted for mastication; feet natatory, not foliaceous, or membranous, always ending in two oars each, composed of two or more joints.

I. ORDER.—Ostracods (Ostracoda).

Body enclosed in a bivalve carapace; first pair of antennæ setaceous, second pair very large, forming natatory oars; two posterior pairs of jaws with a large fan-shaped appendage.

1. Family.—*Cyprises* (Cypridæ). A single large eye on upper part of face; abdomen conical, ending in two styles; two pairs of slender legs.

II. ORDER.—Copepods (Copepoda).

Body divided into several segments, not enveloped in a bivalve test; furnished with foot-jaws, and with four or five pairs of legs.

1. Family—*Pontias* (Pontiidæ). Eyes two, distinct, non-pedunculated; body oval, ending in a narrow prolongation; head distinct, armed in front with a moveable rostrum.
2. Family.—*Cyclopses* (Cyclopidæ). A single eye situated on the middle line at fore and upper part of head; head indistinct, with no moveable rostrum; abdomen elongated.

III. ORDER.—King-Crabs (Xyphosura).

Jaws replaced by the basal part of the six pairs of fore-legs, which are furnished at that part with minute teeth; hind-legs serving for respiration.

1. Family. — *King - Crabs* (Limulidæ). Carapace

large, rounded, divided into two parts, the anterior large and semilunar, the posterior smaller, toothed at the sides, and ending in a long pointed spine.

CIRRHOPODS.

The Cirrhopods, generally known under the names of Acorn-shells and Barnacles, are marine articulated animals, forming a class intermediate between the *Crustacea* and the *Mollusca*. Their body is more or less jointed, and is placed with the back downwards, the cirrhated feet being protruded from the aperture of the shell; the jaws resemble those of Crustaceans, the head is indistinct, and, in the adult, there are no distinct eyes or antennæ; the part corresponding to the abdomen of Crustaceans is furnished with a series of lateral lobes, each bearing two long, curled, many-jointed, ciliated false-feet, which in the living animal are constantly in motion, being alternately protruded and withdrawn, causing currents which procure food and subserve respiration. Their nervous system resembles that of annulose animals, and consists of a double series of ganglia; their blood is white, and they have a complete double circulation; from the circumstance of their bodies being protected by shelly plates, they have been confounded with the *Mollusca*. They are endowed with locomotion only in the young state, but when adult, are always fixed.

The metamorphosis of the Cirrhopods is very curious. The young are hatched from an egg, and resemble the larvæ of *Cyclops* and other *Entomostraca;* they swim freely about, have two long antennæ, three pairs of jointed legs (the hind pair of which is bifid), a bilobed, jointed tail, and eyes. They soon become invested with a coriaceous bivalve shell like that of *Cypris*, to the sides of which the animal fixes itself by the head; the shelly valves then make their appearance; the antennæ and eyes disappear; three more pairs of legs are developed, and the creature finally assumes the shape familiar to our admiring eyes.

The Cirrhopods have a wide range in their geographical distribution, being found in all seas; the particular localities in which they occur are extremely varied. Some sessile forms, as the *Balanidæ*, live attached to tidal rocks, stones and shells; some, as the *Acasta* of Leach, take up their abode in sponges, and the *Catophragmus* of Sowerby in coral; others, again, are found imbedded in Madrepores and *Fungiæ*, as the genera *Pyrgoma*, *Daracia*, *Megatrema* and *Creusia*, while the *Conopea* of Say is affixed to *Gorgoniæ* and horny corals. Some live parasitic in the skins of whales, as the *Cetopirus*, the *Tubicinella*, and the *Diadema;* others, as the *Platylepas* of Gray, and the *Coronula testudinarius*, Lin., fix themselves upon the backs of turtles; others have been found on the bodies of sea-snakes; one, the *Asterolepas lævis* of Gray, on the *Voluta;* and another, the *Coro-*

nula denticulata of Say, on the King-crab. Some of the pedunculated genera form grooves in stones and shells, as *Conchotrya* of Gray, and *Lithotrya* of Sowerby; others are found attached in bunches to floating objects, as *Lepas anatifera*, Linn.; while others again, as the *Alepas parasita* of Lesson, are found parasitic on *Medusæ* and *A. minuta* of Rang, on the spines of the *Cidaris* or Turban-Urchin. The curious genus, *Alcippe* of Hancock, is truly a burrowing Cirrhopod, perforating the substance of shells, and entirely concealing itself in chambers of its own formation, which are lined with a calcareous deposit; the exact mode in which this naked animal, totally unprovided with shelly plates, forms the excavations in which it lives, has not yet been ascertained.

V. CLASS.—CIRRHOPODS (Cirrhopoda).

Animal soft, symmetrical, covered with a fleshy mantle, and fixed in a multivalve shell; body reversed, ending in a tail somewhat jointed and furnished with long, horny, articulated cirrhi subservient to respiration; mouth with mandibles and maxillæ; sexes united. In the young state swim freely about.

I. ORDER.—PEDUNCULATE-CIRRHOPODS (Pedunculata).

Body supported on a coriaceous, hollow, contractile peduncle, fixed to submarine bodies, and usually protected by five shelly valves disposed in two lateral plates, with a medial narrow piece behind.

1. FAMILY. —*Barnacles-proper* (Lepadidæ). Pe-

duncle elongated, naked, fleshy, contractile; body compressed, the sides protected by shelly plates (2.1.2). (*Anatiferidæ*, Gray.)

2. FAMILY.—*Ramphidian-Barnacles* (Ramphidionidæ). Peduncle short, hard, wrinkled or scaly; body compressed, protected by triangular shelly plates. (*Pollicipidæ*, Gray.)

II. ORDER.—BURROWING-CIRRHOPODS (Terebrantia).

Body naked, attached to the upper wall of a chamber, excavated by the animal in some foreign substance, and communicating with the water by an orifice.

1. FAMILY.—*Burrowing-Barnacles* (Alcippidæ). Cirrhi six, composed of three articulations, the last simple; branchiæ setaceous, attached to the external surface of the upper lip.

III. ORDER.—SESSILE-CIRRHOPODS (Sessilia).

Body not peduncled, enclosed in a cylindrical or cone-shaped tube formed of one or more shelly valves; aperture closed by a two- or four-valved operculum.

1. FAMILY.—*Coral-Barnacles* (Pyrgomatidæ). Shell composed of a single undivided cone; aperture small; operculum of two or four pieces; base calcareous, cup-like or tubular. Parasitic on madrepores.
2. FAMILY.—*Acorn-Shells* (Balanidæ). Shell composed of six or eight valves, more or less

united; operculum of four valves; base calcareous or membranous. Living attached to stones, shells, &c.

3. FAMILY.—*Whale-Barnacles* (Coronulidæ). Shell composed of six, distinctly separate, porous valves; operculum of four thin valves united to the margins of the aperture by a membrane; no distinct base. Parastic on whales, &c.

FISH-PARASITES.

The *Epizoa* or Fish-Parasites are either Worm-like or Crab-like: the higher forms, or Carcinoid type, comprehending the "Siphostomes" of Latreille, or those suctorial Crustaceans with rudimentary legs, sometimes in the form of little swimming-paddles, and sometimes shaped like hooks, to enable them to retain their hold on the skins of fishes which most of them infest; the lower forms, or Helminthoid type, partly comprising the *Polycotyla* of Blainville, and sometimes included with the Parenchymatous Parasites of Cuvier.

The shapes these singular animals assume in the various genera are frequently most grotesque, and seem to resemble higher organisms in an embryonic state. In the young stage, they are subject to several metamorphoses, often casting their skin; in this condition they swim freely about, but after they become fixed as parasites, their limbs become rudimentary, and they are not able to enjoy individual progression, although transported along with animals upon whose juices they subsist. The females of the Carcinoid genera nearly always carry their eggs in long cylindrical tubes or ovarian sacs, which arise from the last thoracic segment on each side of the body; the males are frequently very minute, and so unlike those of the other sex, as to resemble totally distinct species. The instruments by means of which the Fish-Parasites retain their hold of the animals they infest, are either sharp curved hooks or prehensile sucking disks; in the Helminthoid families the mouth is very simple, but in the higher Carcinoid forms rudimentary mandibles are seen, together with antennæ and often a single eye. One of the most curious genera is the *Diplozoon*, well named *paradoxum*, an animal which assumes the shape of two united beings forming a kind of Siamese-twins, the bond of communion being simply a narrow band. The bodies named *Pedicellariæ* seen scattered over the surface, and around the mouth of various Echinoderms, have been considered by Monro, Forbes, Oken, and Sharpey as organs of the animals on which they are found. The discovery by one of the authors of an animal resembling those bodies on *Voluta Vespertilio* as a true parasite on the skin, seems, however, to confirm the views of Müller, Lamarck, and Cuvier, in regarding the *Pedicellariæ* as independent parasitic organisms.

VI. CLASS.—FISH-PARASITES (Epizoa).

Animal parasitic on the skin or in the gills and mouths of fishes; mouth tubular, prolonged in the form of a sucker, armed with styliform mandibles; legs natatory or rudimentary.

I. ORDER.—SHIELD-HEADED FISH-PARASITES (Peltocephala).

Head clypeiform, furnished in front with frontal laminæ, and bearing on each side flattened antennæ formed of two joints; thorax jointed; abdomen ending in ciliated fins; feet four pairs, entirely natatory.

1. FAMILY. — *Fresh-water Fish-Parasites* (Argulidæ). Dorsal surface of thorax without lamellar appendages; foot-jaws of second pair replaced by large suckers; legs lamellar, horizontal, and ciliated; abdomen with caudal lamellæ on the under surface.
2. FAMILY. —*Fish-Parasites proper* (Caligidæ). Dorsal surface of thorax without lamellar appendages; no suckers in place of second pair of foot-jaws; legs with long silky plumes; abdomen ending in two small posterior laminæ.
3. FAMILY.—*Elytroid Fish-Parasites* (Pandaridæ). Dorsal surface of thorax with lamellar appendages or elytroids; no suckers in place of second pair of foot-jaws; legs rarely furnished with silky tufts; terminal fins lobular and foliaceous.

II. ORDER.—THICK-HEADED FISH-PARASITES (Pachycephala).

Head thick, obtuse in front, with two slender, cylindrical, setaceous, many-jointed antennæ arising from under its anterior margin; legs not natatory; thorax jointed.

1. FAMILY.—*Tufted Fish-Parasites* (Ergasilidæ). Head large; body pyriform, abdomen conical, ringed, ending in two long tufted appendages; anterior foot-jaws in form of cylindric appendages ending in a two-jointed hook, posterior foot-jaws not cheliform.
2. FAMILY.—*Pincer-bearing Fish-Parasites* (Dichelestiidæ). Head small; body elongated; abdomen rudimentary; legs slightly developed; first pair of foot-jaws cylindrical, ending in a curved hook, posterior foot-jaws sub-cheliform.

III. ORDER.—LERNEAN FISH-PARASITES (Lerneida).

Thorax not jointed; legs always rudimentary; foot-jaws undeveloped.

1. FAMILY.—*Hook-jawed Lerneans* (Chondracanthidæ). Foot jaws in form of strong hooks; antennæ generally distinct; thoracic members of many pairs, free, rudimentary.
2. FAMILY.—*Brachial-Lerneans* (Lerneopodidæ). Thorax with large, brachiform appendages united at the ends; usually with antennæ, and at least two pairs of curved jaw-feet.

3. Family.—*Lerneans-Proper* (Lernæidæ). Head furnished with horns; antennæ none; a single pair of curved jaw-feet; no brachiform appendages.

IV. ORDER.—Worm-like Fish-Parasites (Helminthoidea).

Body worm-like, skin usually without segments; legs rudimentary or reduced to tubercles or hooks; antennæ none; foot-jaws undeveloped.

1. Family.—*Tongue-Worms* (Linguatulidæ). Body flattened, tapering, with imbricate segments; mouth with several suctorial pits containing as many recurved hooks.

In this anomalous family, which is parasitic in the intestines of fishes, the animal, according to the researches of Van Beneden, is provided, in the young state, with two pairs of jointed hooks, the nervous system shews the double-knotted chord, and the ovaries are bulky and internal.

2. Family.—*Double-Worms* (Diplozoonidæ). Body double, each half resembling the other; mouths each with two suckers; hind part of each half furnished with four membranous expansions, each with four prehensile suckers.

This curious form of Fish-parasite is found on the gills of the Bream and other fishes; the stomach is single, but each half of the body contains a distinct system of reproductive organs.

3. Family.—*Hook-tailed Worms* (Gyrodactylidæ).

Hind part of body with a large capsular expansion formed by a thin membrane, the margin of which is sustained by two large hooks and by a crown of simple or double moveable spinous claws.

4. **Family.** — *Cotyloid - Worms* (Octobothriidæ). Mouth anterior and ventral, usually with a tapering cirrhus ; fore part of body tapering, hind part dilated, furnished above or on the sides with six or more prehensible sucking disks or acetabula, simple or armed with hooks.

These *Epizoa* are parasitic on the gills of fishes ; the genus *Aspidocotylus*, however, inhabits the intestines of a species of *Cataphractus*. The genus *Hectocotylus* of Cuvier has been ascertained by F. O. Müller to be one of the detached arms of the male Argonaut containing the spermatic organs. (*Vide* H. and A. Adams "Genera of Mollusca," page 23.)

5. **Family.**—*Disk-Worms* (Capsalidæ). Mouth with a sucker on each side ; body large, flat, disk-like ; lower surface with a large cartilaginous pedunculated sucker of adhesion on hind part.

6. **Family.** — *Plaited - Worms* (Aspidogasteridæ). Body convex above, flat beneath, under surface with a lamina folded on itself, the plaits disposed so as to form numerous pits.

7. **Family.** — *Pedicellate - Worms* (Pedicellariidæ). Body disk-like ; oral orifice in centre of lower concave surface, surrounded by three

incurved hooks; dorsum convex, produced in the middle into a long straight styliform process.

ANNELIDS.

The Red-blooded Worms, as the Annelids are frequently termed, are elongated animals with jointed bodies, and are either aquatic or terrestrial in their habits. They are at once known from other Classes of the *Annulosa* by never having jointed limbs, these being represented by simple bristles. There are regular tentacles in some genera, the head is usually furnished with eyes, and the mouth is often provided with jaws; the most curious character about them, however, is the colour of their blood, which is red, an unusual circumstance among invertebrate animals.

Among the Annelids we find the Tube-worms (*Tubicola*), which construct for themselves coverings either entirely calcareous and fixed to the surface of stones, as the *Serpulæ*, or formed of agglutinated fragments jointed together by an insoluble cement, as the *Terebellæ;* the tufts of gills attached to the front part of the bodies of these animals when fully expanded are adorned with brilliant colours, and form beautiful fans and plumes protruding from the mouth of the shell; sometimes one of the tentacles of the head is formed into a curious funnel-shaped operculum, which protects the creature from injury when it has withdrawn into its shell-like habitation. Some of the Wandering Annelids, as the Sea-Centipedes, swim readily along the surface of the water, and are vividly phosphorescent during the night; most of them, however, live in damp sands along the coast. A few among them attain to considerable dimensions, specimens of *Leodicea gigantea* being known twelve feet in length. The sides of many are covered with beautiful iridescent setæ arranged in tufts; these bristles are often converted into barbs and harpoons, which, however, are enclosed in horny sheaths, into which these sharp weapons of defence can be retracted, and thus avoid injuring their possessor; these are well seen in the *Aphrodite hispida*. Sometimes the bristles are placed on tubercles, and sometimes they are reduced to a few stiff hairs, as in the Earth-worm. In *Nereis prolifera* reproduction occurs by means of spontaneous division, the hind part of the body becoming provided with a new head, and the fore part with a new tail.

In this Class is found the invaluable medicinal Leech (*Hirudo*), and its consimilar, the Horse-Leech (*Sanguisuga*). The species of Leeches employed as medicinal agents, are the *Hirudo medicinalis* and *H. officinalis*, which are principally obtained from the South of France, Sweden, Poland, and Hungary. The cupping apparatus consists of the sucker surrounding the mouth and three jaws with serrated edges placed in a triangle which act the part of scarificators, and which occasion the tri-radiate form of the bite. Of such value is this cupping apparatus of nature considered by the members of the medical profession, that upwards of seven millions are imported into Britain every year by four only of the principal dealers. The *Branchellion* is a peculiar kind of Leech, which is parasitic on the Electric-Torpedo; and another kind has been found attached to the Turtle of the Pacific. The *Planaria* appears to be the molluscan representative among the Annelids; and the remarkable genus *Herpa*, described by Guilding, resembles a *Planaria* which respires free air, being found on decayed fronds of Palms on the summits of high mountains. The *Gordius* and other kindred forms appear to represent the Helminthoid Orders of the Radiate type of animals.

VII. CLASS.—ANNELIDS (Annelida).

Body soft, vermiform, divided into segments or transverse rings more or less distinct; blood coloured (usually red); respiration performed by external or internal gills, or by the skin; organs of locomotion variable, not jointed.

I. *SUB-CLASS.*—POLYPOD-ANNELIDS (Polypoda).

Body provided with distinct feet-like appendages with setæ at their ends, and with various dermoid appendages. Marine.

I. ORDER.—FREE-ANNELIDS (Errantia).

Body extending beyond the oral aperture, and terminated always by a distinct head often provided with eyes and jaws. Dermoid appendages usually disposed over the entire length of body; pediform tubercles furnished with bristles.

I. *SUB-ORDER.*—ANTENNATE-ANNELIDS (Antennata).

Head distinct, with antennæ more or less developed; eyes; and usually a proboscis armed with jaws.

1. FAMILY.—*Sea-Centipedes* (Nereidæ). Mouth with one pair of jaws; body slender; gills in the form of small laminæ; feet with two tubercles, two bundles of bristles and a cirrhus above and below.
2. FAMILY.—*Eunices* (Eunicidæ). Mouth with three pairs of horny jaws; body elongated; gills in the form of tufts; feet with two cirrhi and a bundle of bristles.
3. FAMILY.—*Amphinomes* (Amphinomidæ). Mouth without jaws; body broad, depressed; gills crested or tufted, on each ring of body; feet with two bundles of bristles and two cirrhi.
4. FAMILY.—*Sea-Mice* (Aphroditidæ). Mouth without jaws; body broad, depressed, with two ranges of broad, membranous scales; gills tufted, under the scales; feet with cirrhi and tufts of bristles.
5. FAMILY.—*Polynoes* (Polynoidæ). Mouth with jaws; head with five tentacles; body simple, without scales; feet with cirrhi and tufts of bristles.

6. **Family.** — *Campontias* (Campontiidæ). Body cylindrical, of few joints; pediform appendages two, large, retractile, without cirrhi, furnished with setæ; hook-like organs on the first segment behind the head; penultimate ring with two bundles of bristles; last segment with two large tubercles, each with a circle of hooks.

As in the other families of this Order, there are distinct eyes, tentacles, and horny jaws.

7. **Family.**—*Peripatiens* (Peripatidæ). Body subcylindrical, of few segments, which are again annulate; no distinct gills nor dermal appendages; pediform appendages numerous, without cirrhi at their bases, but with tufts of bristles at their ends.

Like the other members of this Order, there are distinct antennæ, and a proboscis armed with two jaws.

II. *SUB-ORDER.* — EXANTENNATE-ANNELIDS (Exantennata).

Head not very distinct, without antennæ, eyes, or jaws; dermoid appendages none, or branchiform; pediform tubercles often reduced to setæ.

8. **Family.** — *Earth-Worms* (Lumbricidæ). Body elongate, cylindrical, without dermoid appendages, divided by transverse furrows into a great number of rings; rudimentary eyes on the head; mouth simple. Live in perforations of moist earth.

9. **Family.** — *Fresh-water Worms* (Naidæ). Body

elongated, cylindrical, rings indistinct; no dermal appendages; a few setæ in place of feet; eyes on the head; mouth simple. Live in perforations of mud, in fresh water.

10. Family. — *Shore - Worms* (Thalassematidæ). Body soft, elongated, sub-cylindrical, annulate, obtuse behind, the posterior segments spinulose; two shining, hooked spines beneath the neck. Live in perforations of sand, on the sea shore.

11. Family. — *Lob-Worms* (Arenicolidæ). Body with branchial, arbuscular appendages on the middle; segments with bundles of silky bristles; tentacles none; head simple. Live in the sand.

12. Family.—*Bristle-Worms* (Chætopteridæ). Body with branchial appendages in form of small laminæ in a single series on upper sides of body; nine pairs of feet-like appendages, and posteriorly a pair of long silky fasciculi.

13. Family.—*Aricians* (Ariciidæ). Body slender, with the gills in the form of broad laminæ in a series on each side; feet-like appendages with setæ; no posterior silky fasciculi.

II. ORDER.—Sedentary-Annelids (Tubicola).

Body with soft appendages, for the most part collected together at the anterior extremity; feet usually of two kinds, without cirrhi; head not distinct; without eyes or antennæ. Living in attached tubes.

1. Family. — *Amphitrites* (Amphitritidæ). Gills

pectinated, on the fore part of body; oral tentacles numerous, filiform; front of head with golden spines, arranged crown-like or comb-like.

2. **Family.**—*Terebellas* (Terebellidæ). Gills arbuscular, on each side of mouth; oral tentacles numerous, filiform. Tube composed of grains of sand and fragments of shells.

3. **Family.**—*Sabellas* (Sabellidæ). Fore part of body dilated, the sides fringed with setæ; gills fan-like, on each side of mouth; oral tentacles pointed, not modified to serve as an operculum. Tube composed of grains of clay or mud.

4. **Family.**—*Tube-Worms* (Serpulidæ). Fore part of body dilated, fringed with setæ; gills fan-like, on each side of mouth; oral tentacles unequal, one variously modified to serve as an operculum. Tube calcareous, attached.

II. *SUB-CLASS.*—Apodal-Annelids (Apoda).

Body without bristles or feet-like organs for locomotion; head not distinct, but generally provided with eyes and jaws.

I. ORDER.—Suctorial-Annelids (Suctoria).

Body soft, articulation obsolete or indistinct; head not distinct, but furnished with eyes and jaws; organs of locomotion in form of a sucker at one or both extremities of the body.

1. **Family.**—*True-Leeches* (Hirudinidæ). Body ob-

long, depressed, without appendages, transversely wrinkled; a prehensile disk at each end of body; mouth with horny jaws. Aquatic.

2. FAMILY.—*Simple Parasitic-Leeches* (Phyllinidæ). Body wide, depressed, wrinkled, simple above; a disk at the hind extremity only; mouth proboscidiform, without jaws. Parasitic.

3. FAMILY.—*Branchiferous Parasitic-Leeches* (Branchellionidæ). Body depressed, with a double series of branched appendages on the back; oral sucker distinct, separated from the body by a constriction; mouth without jaws; anal sucker large and concave. Parasitic on the Torpedo.

III. *SUB-CLASS.*—NEMERTOID-ANNELIDS (Nemertina).

Body soft, mucous; articulation obsolete; apodal; head indistinct; antennæ none; organ of locomotion an expanded ventral disk, or not defined.

I. ORDER.—MOLLUSCOID-ANNELIDS (Dendrocœla).

Alimentary tube ramifying, arbusculiform; a single oral aperture; anal aperture not distinct.

1. FAMILY. — *Aquatic-Molluscoids* (Planariidæ). Body depressed; oral orifice on middle of lower part of body and proboscidiform; eyes minute, rudimentary. Aquatic.

2. FAMILY. — *Terrestrial-Molluscoids* (Herpidæ). Body depressed, soft, attenuated in front; oral aperture minute, at the extremity of

the body; eyes sessile on the neck; mucous glands on sides of body. Terrestrial.

II. ORDER.—HELMINTHOID-ANNELIDS (Rhabdocœla).

Alimentary tube simple, cylindrical or conical; oral aperture and anus variously disposed.

I. *SUB-ORDER.*—AMPHISTEREANS (Amphisterea).

Neither oral nor anal aperture terminal, but both either superior or inferior.

1. FAMILY.—*Turbellas* (Vorticidæ). Body generally tapering, covered with vibratile cilia; eyes two or four.
2. FAMILY.—*Leptoplanas* (Leptoplanidæ). Body depressed, membranaceous; intestinal canal simple; eyes one or many, on the neck.

II. *SUB-ORDER.*—MONOSTEREANS (Monosterea).

Oral or anal aperture terminal.

3. FAMILY.—*Gordians* (Gordiidæ). Oral orifice terminal, anal inferior; body tapering, filiform, elastic, often coiled up in knots; caudal extremity bifid; eyes none.
4. FAMILY.—*Short-tailed Worms* (Micruridæ). Oral orifice terminal, anal inferior; body tapering, filiform, elastic; tail simple; eyes six or more.
5. FAMILY.—*Long-mouthed Worms* (Derostomatidæ). Anal orifice terminal, oral inferior; body tapering; eyes none. (*Chilophorina*, Ehrenb.)

III. *SUB-ORDER.*—AMPHIPORINES (Amphiporina).

Oral and anal apertures terminal, at opposite ends of the body.

6. FAMILY. — *Gyratrices* (Gyratricidæ). No distinct genital aperture; body tapering; blind, or with numerous eyes.
7. FAMILY.—*Nemertides* (Nemertidæ). A distinct anterior genital aperture; body filiform, soft, often depressed; blind, or with a simple series of frontal eyes.

SUB-KINGDOM OF RADIATE-ANIMALS.

Constructed on a widely extended principle of nature, namely, radiation from a central point, the classes of this Sub-kingdom exhibit extremely simple forms of distinctive animal life. In the lower grades, the growth is unlimited and plant-like, and the digestive cavity possesses only a single terminal orifice, surrounded by tentacles; in the higher forms, however, the alimentary system is more complex, and the anal orifice becomes separated from the oral. Usually the nervous system is distinctly present in the form of a ring surrounding the œsophagus, which gives off filaments in a radiate manner to supply the different parts of the body; the senses are usually but feebly developed, little more than touch and taste having been bestowed upon the members of this Sub-kingdom; their powers of locomotion are also limited, and their muscles weak and rudimentary. In the higher forms the digestive organs are well developed; the circulation is carried on in distinct blood-vessels, although the heart is wanting; and the mode of reproduction is by fertile ova, but without the mutual co-operation of the sexes.

Foremost in the rank of animals constructed on the radiate type, stand the hard and rough-skinned Echinoderms, locomotive stomachs, groping their way, mouth downwards, along the bottom of the sea, true "scavengers of the deep;" singular beings, varying extremely in their outward form; sometimes soft and languid like the worm-like *Holothuria* and the mud-boring *Sipunculus;* sometimes with fixed calcareous stems, and jointed tentacle-like rays, as in the zoophytic Encrinite, or detached and free with compound plumose arms, like the elegant *Antedon;* or sometimes snake-rayed, like the *Ophiurus;* membranaceous, like the *Palmipes;* flattened and shield-shaped, like the *Clypeaster;* ovoid, like the *Spatangus;* or spinose and globular, like the *Echinus* and the *Cidaris.*

Here also we place the *Acalephæ*, elegant pellucid beings, symmetrical and of delicate organization, and yet the sport of oceanic waves; whose skin, though not of leathery toughness or bony consistence, yet possesses the remarkable power of paralyzing their prey, and producing a stinging sensation when handled. Like the Star-fishes and the Sea-Urchins, these likewise exhibit various forms —departures from the usual stellate type. Thus we have the globular *Beroe* rolling along the surface of the sea; the crested *Physalia,* with its hydrostatic float; the disk-like *Cuvieria;* the *Rhizostoma* and *Medusa* with their umbrelliform bodies and tentacular filaments; the *Velella* with its little lateen sail; and the *Cestum,* like a long translucent riband.

Next come the *Rotifers,* spinning through the stagnant waters by means of ciliated wheel-like organs, which appear to have a revolving motion, —singular but minute animals, whose bodies are enclosed in clear pellucid shells, and whose gizzards are armed with powerful teeth for crushing their food, and which, moreover, possess the extraordinary property of being restored to life and activity after they have been completely dried up and converted into dust. Belonging also to that division in which the oral and anal apertures are distinct, we find the phytoid *Polyzoa,* animals so like the *Polypifera* as formerly to have been confounded with them. As in the true Polyps, their mouth is surrounded with tentacles, but the digestive apparatus, instead of being confined to a simple stomach with an oral orifice, is produced into an alimentary canal furnished with a distinct excretory aperture; the tentacles, moreover, are not simple as in the *Polypifera,* but are fringed with vibratile cilia, which produce rapid and powerful currents to direct the food towards the opening of the mouth.

The class of *Cœlelmintha,* or Cavitary-Parasites, recedes more, perhaps, from the radiate type than any of the others, the creatures comprising it having long, flexible, worm-like bodies, but whose nervous system is composed of a collar surrounding the gullet, from which filaments are distributed to various parts of the body, and where the radiate character is still preserved in the organs that surround the mouth.

Belonging to those organisms of a humbler type of structure, but still created on the grand radiated model, we observe the *Polypifera*, in which we find the organs of the senses gradually disappearing, and the individual becoming reduced to a mere stomach, either fixed or endowed with locomotion, and furnished with organs, by means of which it procures itself food, for in these flower-like living stomachs no digestive canal is appended, and there is no distinct excretory orifice ; the growth, moreover, is indefinite and plant-like, taking place by gradual deposits on the outside, by means of a number of polyps, which we may compare to buds. In the class of Parenchymatous-Parasites or *Sterelmintha*, we again observe a departure from the typical form of this Sub-kingdom, in creatures of low organization with a single oral aperture leading to a simple stomachal cavity, and destined to subsist on substances already elaborated by the animals upon which they are parasitic.

IV.—SUB-KINGDOM—RADIATE-ANIMALS (Radiata.)

Nervous system without ganglia, composed of simple filaments disposed in a circular form round the buccal orifice; organs of body arranged in a radiate manner round the digestive cavity; not amorphous or bilateral; organs of digestion a simple sac or short alimentary canal. Animal mostly aquatic, breathing by gills, usually free.

ECHINODERMS.

Echinoderms constitute an exceedingly natural and well-defined group of Radiate Animals, of which Sub-kingdom they form the first and most highly organized class. They derive their name from the spiny covering with which many of them are invested, whence also the popular designation of the typical order, "Sea-Urchins." Others again, from a fancied resemblance between their rayed outline, and the popular idea of the true figure of the celestial bodies, are generally known as "Star-Fishes," and "Sea-Stars." They are all aquatic, without exception marine, and include among their number some of the loveliest inhabitants of the deep, the more stellate forms, especially, appearing to the imagination as reflected images of the starry heavens.

Being very generally distributed, they will frequently arrest the attention of the observant traveller in the progress of his researches along the sea-coast and the neighbouring waters. Buried in sand he will occasionally find Brittle-Stars (*Ophiolepis, Ophiopholis, Ophiothrix*), and in rock-pools young specimens of many of the *Asteriidæ*, as *Asterias*, *Henricia*, &c., or full grown Starlets (*Asterina*). There also, or on rocks, he will frequently discover various members of the family *Echinidæ;* and if he happens to visit Madeira, a species of *Ophidiaster*, mentioned by Lowe, may be sought for. A greater variety will, however, reward an examination beyond low-water mark, for which purpose a dredge is requisite. Here, if the bottom be sandy, he will bring up examples of many of the *Ophiuridæ*, and in the bay of Panama he may include among his captures the genus *Gymnasteria*. From rocky bottoms with deep water in our own seas the Spiny-Crossfish sometimes appears; on fishermen's lines he will often see the Common-Crossfish busily engaged in devouring the bait; and after the same fashion other Echinoderms, as *Porania* and *Pentacta* may be procured. On examining the leaves of Fuci brought up in dredging, he may perchance be rewarded by the appearance of a graceful Feather-Star (*Antedon*), more frequently by a showy Sun-Star (*Solaster*), and on the stems of *Laminaria* a small Holothurian genus, (*Psolinus*), may be found. At various depths, from two or three fathoms as far as twenty or thirty fathoms, at different times will occur Sand-Stars, Cushion-Stars (*Porania*, *Hippasteria*), Bird's-foot Sea-Stars (*Palmipes*), Egg-Urchins (*Echinus*, *Echinometra*, &c.), Pea-Urchins (*Echinocyamus*) Heart-Urchins (*Echinocardium*), also *Clypeaster*, *Spatangus*, and many others. Huge, unwieldy, but curiously constituted *Holothuriæ* may present themselves, or worm-looking *Sipunculidæ*, sometimes, Cuckoo-like, occupying habitations not of their own construction. The collector may very possibly be foiled in his most determined attempts to preserve intact some obstinately-fragile *Luidia*, which not only refuses to be captured entire, but, according to Forbes, adds insult to disappointment, by vexatiously winking at its baffled tormentor. In deeper water in northern seas a stray Gorgon's-Head (*Astrophyton*), with its strangely twisted arms, may remind its captor of Medusa, with her tangled locks; a rare Cake-Urchin (*Echinarachnius*) may enrich his collection; or, if off the Zetland Islands, a fine, showy "Piper" (*Cidaris*), with its long, cylindrical spines, like the drones of a bag-pipe, may amply reward a day of toil. In tropical seas specimens of pedunculated *Pinnigrada* (*Pentacrini*) should be diligently sought for, and, if obtained, will prove valuable acquisitions, both from their great rarity, and from the knowledge afforded by their structure of extinct, allied genera. Much may be done in collecting members of this class in eastern and southern regions, as China, Japan, and Australasia, many also inhabit the shores of the great Pacific Ocean, the seas around the Cape of Good Hope, the Red Sea, and the Mediterranean. The stomachs of fish, especially of such as are in the habit of preying upon these animals, should, when practicable, be carefully examined, as not only have rare examples been frequently so obtained, but by the same means new species have at times been revealed to science. A curious form (*Rhopalodina*) has been lately described by Dr. Gray, which presents many striking affinities both with the *Holothuriæ*, and with the *Vermigrada;* judging from the published description that the former predominate, we have placed it provisionally among the *Cirrho-Vermigrada.*

From the numerous fossil remains of animals of this Class, they appear to have been very abundant during former eras. They occur in Palæozoic rocks, also in various parts of the Oolitic and Cretaceous systems, and in many tertiary formations. Among the most singular are the Encrinites, or "stalked *Pinnigrada,*" now nearly extinct. Their remains are popularly known as "Lily-stars," and fragments of the stalks or peduncles, from occurring plentifully in Holy-Island, were by our pious ancestors named "St. Cuthbert's beads," according to the tradition, that

> "On a rock by Lindisfarne,
> St. Cuthbert sits, and toils to frame
> The sea-born beads that bear his name."

Accordingly, in the middle ages they were strung and used as rosaries, being in Germany, also, known as "bead-stones," or "St. Boniface's pennies."

Among the Malays and Chinese some Holothurian species are used as food under the name of "Trepang;" and in Europe the Common Sea-urchin (*Echinus esculentus*) is, as its specific name implies, frequently accounted edible. In some parts of the Mediterranean, especially among the islands of the

Grecian Archipelago, another species (*E. lividus*) is also occasionally eaten by goatherds and fishermen.

In the following arrangement the orders are those of Professor E. Forbes; the families are from various sources, those of the *Cirrhigrada* being in accordance with Dr. Gray's monograph.

I. CLASS.—ECHINODERMS (Echinodermata).

Animal mostly free; body in the typical orders radiate, with a quinary division of segments, in the rest molluscoid or annuloid; usually covered with a coriaceous skin, strengthened in some by calcareous plates or spines. Progression by means of cirrhi or suckers, or, in some, by contraction and extension of the body.

I. ORDER.—WORM-LIKE ECHINODERMS (Vermigrada).

Body annuloid; cirrhi obsolete, or only as bristles; motion effected by contraction and extension of the body; mouth seldom surrounded with tentacles.

1. FAMILY.—*Spoon-Worms* (Thalassemidæ). Body oval or oblong; proboscis with a long, fleshy appendage; vent at posterior extremity; tentacles none.
2. FAMILY.—*Fork-nosed Worms* (Bonnelliidæ). Body oval; proboscis very protractile, forked at the extremity; vent at posterior extremity; tentacles none.
3. FAMILY.—*Tailed-Worms* (Priapulidæ). Body

cylindrical, truncate posteriorly; proboscis sub-conical, retractile; caudal appendage long, pyramidal, filiform, with the vent at its extremity; tentacles none.

4. Family.—*Syphon-Worms* (Sipunculidæ). Body cylindrical, elongate; skin rugose; proboscis retractile; vent at base of proboscis, surrounded by a circle of tentacles.

II. ORDER.—Slug-like Echinoderms (Cirrho-Vermigrada).

Body molluscoid; quinary division obscure; motion effected by rows or groups of cirrhi, assisted by contraction and extension of body; mouth and anus at opposite extremities of body; mouth surrounded by tentacles.

I. *SUB-ORDER.*—Apodal-Holothurians (Apoda).

Suckers undeveloped, or absent?

1. Family. — *Vermiform - Holothurians* (Synaptidæ.) Body cylindrical, vermiform, contractile, covered with numerous minute papillæ; mouth surrounded by tentacles, which are usually digitate or pinnatifid

2. Family.—*Sea-Gourds* (Rhopalodinidæ). Body elongate, rigid, brittle, covered with imbedded calcareous plates; anterior extremity cylindrical, tubular, posterior dilated suddenly, ovate, somewhat compressed, with a slight keel on each of the two edges; pos-

terior half of dilated portion furnished with ten ambulacra.

II. *SUB-ORDER.*—PEDATE-HOLOTHURIANS (Pedata.)

Body furnished with suckers variously arranged.

3. FAMILY.—*Sea-Cactuses* (Thyonidæ). Body pyriform when at rest, cylindrical when extended, contractile; covered all round with numerous papillose suckers; tentacles ten, branching.
4. FAMILY.—*Sea-Melons* (Pentactidæ). Body more or less angular or cylindrical; suckers arranged in five longitudinal rows; tentacles pinnate or ramose.
5. FAMILY.—*Holothurians-proper* (Holothuriidæ). Body cylindrical or flattened horizontally, cartilaginous or gelatinous; mouth somewhat inferior; suckers principally over inferior surface, irregularly scattered, a few on the dorsal surface; tentacles mostly twenty, short, peltate.
6. FAMILY.—*Trepangs* (Trepangidæ). Body cylindrical or sub-cylindrical, soft, gelatinous, with numerous papillæ on back; mouth anterior; suckers placed on inferior surface; tentacles 6—8 ? peltate.
7. FAMILY.—*Scaly-Holothurians* (Cuvieriidæ). Body convex superiorly, sometimes with bony plates; inferior surface soft, flat, with numerous suckers; oral opening tentacular, stellate.
8. FAMILY.—*Sea-Cucumbers* (Psolidæ). Body ir-

regular, molluscoid; suckers mostly in three rows, on a circumscribed disk on inferior surface; animal when moving turns up the two extremities.

III. ORDER.—True-Echinoderms (Cirrho-Spinigrada).

Body covered with closely-jointed, calcareous plates, mostly armed with spines; lobes obscure; arms none; progression by joint action of suckers and spines.

I. *SUB-ORDER.*—Aiolopygians (Aiolopygia).

Vent eccentric, sometimes marginal.

1. Family.—*Heart-Urchins* (Spatangidæ). Body irregular, cordate or ovate; some with long slender spines; mouth transverse, sub-central or lateral, surrounded in some by tentacles; vent terminal; ambulacra not continuous; teeth none; ovaries four.
2. Family.—*Helmet-Urchins* (Galeritidæ). Body conoid or sub-oval, base flattened; mouth inferior, usually central; vent marginal; ambulacra extend from middle of back to mouth, sometimes interrupted at the margin; jaws rudimentary.
3. Family. —*Shield-Urchins* (Scutellidæ). Body mostly flat and depressed, seldom convex, margin orbicular or oval, sometimes rayed or pierced with holes; mouth inferior, central; vent sub-central or marginal; ambulacra petaloid, forming arched series on the middle

of the back, not continuous; jaws complicated; ovaries five.

II. *SUB-ORDER.*—AKROPYGIANS (Akropygia).

Mouth inferior, central; vent superior, apical.

4. FAMILY.—*Sea-Urchins* (Echinidæ). Body globose, sometimes depressed; ambulacra five, continuous from mouth to apex; spiniferous tubercles simple, rounded; spines generally numerous, mostly equal sized; ovaries five; dental apparatus complex.

5. FAMILY.—*Turban-Urchins* (Cidaridæ). Body oblato-spheroidal; ambulacra continuous, from mouth to vent; spiniferous tubercles perforate; spines often of different kinds, usually long, unequal, seldom numerous; teeth complicated; ovaries five.

IV. ORDER.—TRUE-STARFISHES (Cirrhigrada.)

Form stellate or angular; body covered with a tough, leathery integument, more or less strengthened with a net-work of calcareous plates, and in most with strong spines; mouth central, inferior, from which radiate to the extremities of the arms grooves (ambulacra) containing extensile suckers.

I. *SUB-ORDER.*—DISTACHIAN-STARFISHES (Distachiata).

Ambulacral grooves with two rows of suckers.

1. FAMILY.—*Membranous Sea-Stars* (Asterinidæ). Body discoidal or pyramidal, mostly pentagonal, sharp edged; skeleton formed of com-

pressed, imbricate plates; dorsal wart single, rarely double.

2. FAMILY.—*Porous Sea-Stars* (Pentacerotidæ). Body mostly pentagonal or sub-orbicular, in some discoidal, supported by roundish or elongated pieces, covered with a smooth or granular skin, pierced with minute pores between the tubercles; rays mostly short, but in some elongated.

3. FAMILY.—*Tubercular Sea-Stars* (Astropectinidæ). Stellate or multi-radiate; back flattish, netted with numerous tubercles, crowned with radiating spines at the tip, named *Paxilli;* arms mostly more or less rounded.

II. *SUB-ORDER*—TETRASTACHIAN-STARFISHES (Tetrastachiata).

Ambulacral grooves with four rows of suckers

4. FAMILY.—*Sea-Stars proper* (Asteriidæ). Rays generally five, usually rounded, elongate, sometimes spiny; dorsal wart simple.

V. ORDER.—SPINOUS STARFISHES (Spinigrada).

No branchial membranes; body covered with calcareous scales or plates; form regularly radiate; true arms, clothed with spines by which motion is effected.

1. FAMILY.—*Brittle-Stars* (Ophiuridæ) Body orbicular, depressed, covered with spines or scales; arms mostly five, simple, with cross series of spines on the sides; mouth inferior, central.

2. **FAMILY.**—*Gorgon-Heads* (Euryalidæ). Body orbicular, depressed, covered with a leathery skin, strengthened behind by five pairs of radiating ribs; arms compressed, rounded or square, with a series of pores on each side, and usually repeatedly branching; mouth inferior, central.

VI. ORDER.—PINNATE-ARMED STARFISHES (Pinnigrada).

Rays furnished with pinnæ, having the skin developed on their sides, so as to be the principal organs of progression through the water; generative system spread over tegumentary covering of body and arms; free, or attached to foreign bodies by a peduncle.

I. *SUB-ORDER.*—FREE-CRINOIDEANS (Liberida).

Either permanently unattached or become so in their mature state; some furnished with a tapering column, enabling the animal to attach or detach itself at will.

1. **FAMILY.**—*Feather-Stars* (Antedonidæ). Rays five, subdivided and pinnate, resembling feathers; free when adult, young fixed and stalked. (*Comatula,* Lam.)

II. *SUB-ORDER.*—FIXED-CRINOIDEANS (Cionacineta).

Fixed to extraneous objects, usually by a jointed, flexible column attached to the dorsal surface.

2. **FAMILY.**—*Pedunculated Lily-stars* (Pentacrinitidæ). Rays with numerous jointed lateral appendages; peduncle five-sided, jointed, with

several whorls of secondary simple rays, which are destitute of lateral appendages.

Of this family, so abundant in former ages, the only existing representatives are one or two little known tropical species.

3. FAMILY.—*Sessile Lily-stars* (Holopodidæ). Body short, thick; rays dichotomous, convex externally, grooved along the inside, with numerous compressed conical armlets; oral and anal opening in common (?)[*]; sessile or nearly so, and permanently fixed.

The only known recent example of this family is the curious genus *Holopus* of D'Orbigny.

SEA-NETTLES.

In the warmer regions of the globe, the surface of the ocean teems with transparent, fragile beings of delicate organization, sometimes of considerable dimensions, and possessed of a peculiar stinging power, but oftener of minute size, and only rendered obvious by their phosphorescent properties These are the Sea-Nettles (*Acalephæ*), or as they are frequently termed, "Sea-Blubbers" and "Jelly-fishes."

They are distributed into groups according to their organs of progression through the water. In the Pulmonigrade forms the animals resemble mushrooms, sometimes with roots depending from their lower surface, and often with the margin of their disk simply fringed. The larger kinds, as *Medusa* and *Cydippe*, are often seen languidly floating in calm weather in our harbours, making their way slowly by the regular expansion and contraction of their umbrella-like bodies. In the Ciliograde kinds, as may be observed in the globular *Beroe*, the organs of progression are in the form of long filaments, which enable their possessors to roll along through the water in a very rapid manner, often appearing, as they turn about, perfectly iridescent. One of them, of singular transverse flattened form, the "Girdle of Venus" (*Cestum Veneris*), appears like a luminous snake, as its long riband-shaped body, vividly phosphorescent, and often five or six feet in length, passes along the surface of the water during a tranquil night. Among the Physograde families, we find the well-known Portuguese-man-of-war (*Physalia pelagica*), those purple-crested vesicles seen by the voyager floating so buoyantly in fleets upon the bosom of the tropical seas. In the Cirrhigrade division we meet with another delicate sailor in the form of the *Porpita*, with its purple tentacles and circular disk-like skeleton; here likewise we find *Velella*, also with a cartilaginous support and of a lovely blue colour, but with an oblique vertical plate on the horizontal surface, which acts like a little lateen sail. In the Diphydous Order are placed those curious double gelatinous animals the *Salpæ*, which resemble two little glassy bells, one fixed to the inside of the other; these perfectly transparent creatures are also pelagic, and swim through the water with tolerable velocity, propelled by the alternate contractions of the bell-shaped halves of their bodies.

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[*] D'Orbigny.

The Sea-Nettles are predaceous in their habits, and, notwithstanding the extremely delicate nature of their organization, are enabled frequently to seize and devour animals of much greater power by means of their long stinging tentacles, which enlace their victims, and at the same time benumb them.

II. CLASS.—SEA-NETTLES (Acalephæ).

Animals soft, aquatic, free, gelatinous, emitting an acrid secretion; mouth and anus distinct. Swim by contractions of the mantle, or by air-bladders.

I. ORDER.—PHYSOGRADE SEA-NETTLES (Physogradæ).

Body symmetrical, bilateral, fleshy, contractile, provided with an aeriferous sac.

1. FAMILY.—*Portuguese Men-of-war* (Physaliidæ). Vesicle large, irregular, without stalk or ampullæ; with terminal suckers and cirrhi.
2. FAMILY.—*Bubble-bearers* (Physophoridæ). Vesicle small, regular, on a stalk, with lateral ampullæ and terminal suckers.
3. FAMILY.—*Scale-bearers* (Rhodophysidæ). Locomotive organs in the form of smooth scales, disposed in transverse series.

II. ORDER.—PULMONIGRADE SEA-NETTLES (Pulmonigradæ).

Body entirely gelatinous, circular, without any solid axis; margin with cirrhi or folicaceous appendages pendent from the lower surface.

1. FAMILY.—*Simple Jelly-fishes* (Eudoridæ). Simple, without true tentacles, peduncles, or arms.
2. FAMILY.—*Tentacular Jelly-fishes* (Æquoreidæ). Circumference of body, and sometimes the mouth, surrounded by tentacles.
3. FAMILY.—*Pedunculate Jelly-fishes* (Oceaniidæ). Gastric cavity prolonged into a sharp peduncle, at the end of which is the mouth, surrounded by four brachial appendages.
4. FAMILY.—*Proboscis Jelly-fishes* (Geryoniidæ). Lower and central part of body prolonged into a proboscis-like appendage, either simple, or provided with arms.
5. FAMILY.—*Jelly-fishes proper* (Medusidæ). With a central mouth; lower surface furnished with more or less numerous ramified brachial appendages.
6. FAMILY.—*Root-mouthed Jelly-fishes* (Rhizostomatidæ). Without an open mouth in the centre; nourished by suction through the tentacular ends of their ramified peduncle.

III. ORDER.—CIRRIGRADE SEA-NETTLES (Cirrigradæ).

Body oval or circular, gelatinous, supported by an internal, sub-cartilaginous body, and with extensile, tentacular cirrhi pendent from the whole of the under surface.

1. FAMILY.—*Velellas* (Velellidæ). Body discoid or

irregularly oblong, flat above, with a vertical lamina on the upper surface.

IV. ORDER.—Diphydian Sea-Nettles (Diphydæ).

Body bilateral, symmetrical, with two or more hollow, contractile, sub-cartilaginous swimming organs, placed one before the other; an ovigerous filament prolonged posteriorly.

1. Family. — *Diphyds-Proper* (Diphyidæ). Body composed of two pieces adhering together, and capable of separation.
2. Family.—*Polytomes* (Polytomidæ). Body composed of numerous pieces aggregated together.

V. ORDER.—Ciliograde Sea-Nettles (Ciliogradæ).

Body gelatinous, free, marked on the surface with narrow ambulacra formed by rows of vibratile cilia.

1. Family.—*Beroës* (Beroidæ). Body symmetrical, terminated at each pole by an opening, with ciliated ribs and two ciliated tentacles arising from the inferior extremity.
2. Family.—*Alcynoës* (Alcynoidæ). Body cylindrical, open at one end, furnished at the other with two large wings which often envelope the entire body; ribs of body ending in a point.
3. Family.—*Winged-Beroës* (Callianiridæ). Body with projecting ciliated ribs, united together and forming lateral wings. In *Cestum* the ribs are two, and the wings excessively prolonged.

ROTIFERS.

The Rotifers or "Wheel-Animalcules" have been so designated on account of the little, ciliated, circular organs which serve them as means of progression through the water, for, like the Infusory or Polygastric Animalcules, they are all aquatic. Like those organisms, also, they are extremely minute, but their structure is much more complex, the intestinal canal having two distinct openings like that of the *Polyzoa*, to which they somewhat closely approach. In fact, these small and delicately organized Rotifers are covered with a clear, transparent skin, which corresponds to the hardened shells of the *Polyzoa*, to which they seem to have the same relation that the *Tunicata* have to the bivalve acephalous *Mollusca*. The front part of their thin, coriaceous envelope is open, and frequently toothed round the margins, the hind part is closed, and usually ends in a little pair of forceps, which serves the purpose of anchoring the individuals to fixed or floating bodies. The ciliated wheels which constitute the organs of locomotion of these little animals do not actually rotate, but only appear to do so, on account of the rapid undulations of their marginal cilia. One very remarkable feature in the organization of these microscopic beings, is the presence of a muscular gizzard with distinct teeth, for the purpose of masticating or grinding the food which is conveyed to their stomachs by the incessant vibratile action of their ciliated wheels. The Wheel-Animalcules propagate their species by means of eggs, or *ova*, which are invested with a thin transparent shell, through which the embryo Rotifer may be plainly discerned.

III. CLASS.—ROTIFERS (Rotifera).

Mouth in general armed with jaws, and furnished with rotatory cilia; intestinal canal ending by two distinct orifices; formed for swimming. Reproduce by eggs.

I. ORDER.—MONOTROCHIANS (Monotrocha).

A single continuous ciliated wheel.

1. FAMILY.—*Fish-Rotifers* (Ichthydiidæ). Margins of the rotatory organ entire; skin soft or naked.
2. FAMILY.—*Social-Rotifers* (Œcistidæ). Margins of wheels entire; skin hard or loricated.
3. FAMILY.—*Large-wheeled Rotifers* (Megalotrochidæ). Margins of the rotatory organ incised or flexuous; not enclosed in a shell.
4. FAMILY.—*Bristle-Rotifers* (Flosculariidæ). Loricated; rotatory organ with sinuous, lobed, or multifid margins.

II. ORDER.—SOROTROCHIANS (Sorotrocha).

A compound or divided ciliated wheel.

1. FAMILY.—*Pellucid-Rotifers* (Hydatinidæ). Body without a shell; rotatory organ many-parted.

2. FAMILY.—*Crab-Rotifers* (Euchlanidæ). Body loricated; wheels many-parted.
3. FAMILY.—*Rotifers-proper* (Rotiferidæ). Body without a shell; rotatory organs two, separate.
4. FAMILY.—*Tortoise-Rotifers* (Brachionidæ). Body loricated; rotatory organ double.
5. FAMILY.—*Tardigrade-Rotifers* (Macrobiotidæ). Body with four pairs of short legs, each ending in two pairs of small claws.

ASCIDIAN-POLYPS.

The Ascidian-Polyps are compound plant-like animals of great interest and beauty; on account of their branching fronds and phytoid aspect they were named by Ehrenberg *Bryozoa*, or "animal mosses;" but the designation of our own countryman, J. V. Thompson, claims priority. Although in general they possess the form of the *Polypifera*, they have been shewn to have an organization so superior to that of the true Polyps as to authorize their removal to another section. They are in fact provided with a distinct alimentary canal with two orifices, and externally are at once distinguished from the *Polypifera* by the ciliated tentacles which surround the mouth. The individual polyp-like animals are frequently lodged in little horny cells, which are sometimes isolated as in the genus *Bowerbankia;* sometimes arranged side by side as in *Eschara* and *Flus-*

tra, and some among them are even free, as the fresh-water genus *Cristatella*. In some forms the cells are very thin and pellucid; in others they are horny or membranous; while many again inhabit cells of a hard calcareous material. The general form of the polyzoary is susceptible of very great variation, from the broad palmate expansion of the *Flustra foliacea* to the lobate fleshy *Alcyonidium;* from the long tubular cells of the *Tubulipora* to the elegant, jointed *Eucratea;* from the crustaceous *Lepralia* to the plant-like *Salicornaria;* or, lastly, from the locomotive *Cristatella* to the fixed confervoid *Plumatella*. These remarkable little animals are usually found adhering by a kind of root to stones, rocks, and other marine bodies, their delicate and fragile forms being swayed to and fro by the motion of the water that surrounds them; and, often after storms, they strew the sandy shores with their elegant uprooted fronds. The increase of the *Polyzoa* is by buds or gemmules, but some among them are developed from ova, which minute eggs are covered by a remarkable shell, being furnished with numbers of little horny hooks to enable them to retain their hold upon marine bodies.

IV. CLASS.—ASCIDIAN-POLYPS (Polyzoa).

Animal polypiform, enclosed in horny or calcareous cells, united together in a common mass; digestive canal with a distinct mouth and vent; mouth surrounded with eight or more, ciliated, retractile tentacles.

I. ORDER.—Marine Ascidian-Polyps (Infundibulata).

Polyps compound, mouth surrounded with ciliated, filiform, retractile tentacles, which form an uninterrupted circle; ova ciliated. Marine.

I. *SUB-ORDER.*—Lip-mouthed Ascidian-Polyps (Chelostomata).

Aperture of cell filled with a thin membranous or calcareous velum, with a crescentic mouth, provided with a moveable lip.

I. TRIBE.—Jointed Ascidian-Polyps (Articulata).

Polyzoary divided into distinct portions or joints, by flexible articulations.

1. Family.—*Chain-like Ascidian-Polyps* (Catenicellidæ). Cells disposed in a single series, and connected by flexible joints. The cells are horny, and arise one from the other by a short continuous tube, all facing the same way, and forming dichotomously divided branches.
2. Family.—*Salicornian Ascidian-Polyps* (Salicornariidæ). Cells disposed in a double or multiple series, around an imaginary axis, forming cylindrical branches of a dichotomously divided, erect polyzoary; branches of polyzoary with distinct articulations.
3. Family.—*Cellular Ascidian-Polyps* (Cellulariidæ). Cells disposed in a double or multiple

series in the same plane, forming linear branches of a dichotomously divided, phytoid, erect polyzoary.

II. TRIBE.—JOINTLESS ASCIDIAN-POLYPS (Inarticulata).

Polyzoary continuous throughout.

4. FAMILY.—*Club-celled Ascidian-Polyps* (Scrupariidæ). Cells disposed in a single series; junctions rigid, or of the same consistence as the cells; polyzoary usually loosely adnate. The cells are elongate, clavate, with an oblique, subterminal aperture with a simple margin.
5. FAMILY.—*Alternate-celled Ascidian-Polyps* (Farcimenariidæ). Cells disposed in a double or multiple series round an imaginary axis, alternate, forming cylindrical branches of an erect, dichotomously divided, continuous polyzoary.
6. FAMILY.—*Opposite-celled Ascidian-Polyps* (Gemellariidæ). Cells disposed in a double or multiple series; cells opposite, in pairs. Differs from *Bicellariidæ* in general habit, in the position of the cells in pairs, and in the absence of *avicularia*.
7. FAMILY. — *Tentacular Ascidian-Polyps* (Cabereidæ). Polyzoary dichotomously divided into ligulate, bimultiserial branches; on the backs of which are *vibracula* or *avicularia*, one common to several cells; *avicularia* sessile.
8. FAMILY.—*Bicellular Ascidian-Polyps* (Bicella-

riidæ). Polyzoary dichotomously divided into narrow, ligulate, bi- or multi-serial branches; no *vibracula; avicularia*, when present, pedunculate and articulated; polyzoary erect, phytoid.

9. FAMILY.—*Foliaceous Ascidian-Polyps* (Flustridæ). Polyzoary flexible, expanded, foliaceous, erect, sometimes decumbent and loosely attached; cells multi-serial, quincuncial, or irregular.

10. *Cellular Ascidian-Polyps* (Celleporidæ). Polyzoary calcareous, cellular, composed of ovate cells in juxta-position; the aperture terminal, often furnished with a globular capsule.

11. FAMILY.—*Membranous Ascidian-Polyps* (Membraniporidæ). Polyzoary forming a gauze-like incrustation, loosely adherent; cells oblong, quadrangular, with a blunt hollow spine at each angle.

12. FAMILY.—*Honey-comb Ascidian-Polyps* (Escharidæ). Polyzoary membrano-calcareous, frondescent; the cells immersed in a double layer placed back to back, like the cells in honey-comb.

II. *SUB-ORDER.*—ROUND-MOUTHED ASCIDIAN-POLYPS (Cyclostomata).

Aperture of cell simple, circular.

13. FAMILY.—*Tubular Ascidian-Polyps* (Tubuliporidæ). Polyzoary massive, orbiculate or

lobed; cells long and tubular, with a round, prominent, unconstricted aperture.

14. FAMILY.—*Confervoid Ascidian-Polyps* (Crisiidæ). Polyzoary plant-like, dichotomously branched, jointed; cells tubular, in one or two series, with the circular apertures alternately looking to opposite sides.

III. *SUB-ORDER.*—FRINGE-MOUTHED ASCIDIAN-POLYPS (Ctenostomata).

Aperture of cell with a more or less well-marked fringe of setæ around the margin when the animal is protruded.

15. FAMILY.—*Vesicular Ascidian-Polyps* (Vesiculariidæ). Polyzoary slender, plant-like, horny, fistular; aperture of polyp-cell fringed; body of polyp separate from walls of cell, which is deciduous.

16. FAMILY.—*Pedicellate Ascidian-Polyps* (Pedicelinidæ). Polyzoary pedunculate, clavate, rising from a filiform, creeping shoot; body of polyp adnate to cell.

IV. *SUB-ORDER.*—FLESHY ASCIDIAN-POLYPS (Halcyonellea.)

Polyzoary sponge-like, fleshy, polymorphous; cells irregular in disposition, immersed; aperture contractile; no ovarian capsules.

17. FAMILY.—*Sponge-like Ascidian-Polyps* (Alcyonidiidæ). Polyzoary fleshy, lobed; cells with fibro-corneous walls; aperture terminal,

simple, contractile; polyps with a double sheath.

II. ORDER.—Fresh-water Ascidian-Polyps (Hyppocrepia).

Lacustrine, or natives of fresh water; polyps compound; mouth surrounded with ciliated, retractile tentacles, interrupted or depressed on one side so as to assume a crescentic or horse-shoe form; ova not ciliated.

1. Family.—*Crested Ascidian-Polyps* (Cristatellidæ). Polyzoary free, floating, contractile, locomotive; polyps issuing from apertures arranged upon the upper surface; tentacular disk crescentic.
2. Family.—*Plumose Ascidian-Polyps* (Plumatellidæ). Polyzoary fixed, incrusting, confervoid or sponge-like, inarticulate, composed of aggregated membranous tubes opening on the surface.
3. Family. — *Marsh Ascidian-Polyps* (Paludicellidæ.) Polyzoary fixed, jointed, coriaceous; composed of a single series of claviform cells with a concatenated arrangement; apertures uni-lateral, tubular, near the wide end of the cell.

CAVITARY-PARASITES.

The *Cœlelmintha* of Owen, or the "Vers cavitaires" of Cuvier, assume a much higher standard of organization than the "Vers parenchymateaux" of the same illustrious savan. Together these two types of structure constitute the *Entozoa* of many authors, from the greater number living in the intestines and other internal parts of various animals. In these higher forms, nervous fibres connect the different organs of the body by a common sympathy; the muscles become more apparent and assume greater energy; the alimentary tube is enclosed in walls of its own, and not simply hollowed out of the tissues; it, moreover, possesses two distinct orifices, an oral and an anal; and the sexes are separate in different individuals. The bodies of these parasites are worm-like, long, elastic, and cylindrical, are never provided with limbs or organs of locomotion, while the only sense they seem to possess is that of touch. They obtain their food by dwelling always parasitically in the bodies of other animals, subsisting on their juices. Among these by no means attractive members of the kingdom of animals we find the Guinea worm (*Filaria medinensis*), which burrows beneath the skin, and sometimes grows to several feet in length; the *Ascaris lumbricoides*, which lives upon the substances of the intestinal canal already elaborated for it by man and quadrupeds; the *Ophiostoma*, which inhabits the air-bladders of fishes; and others are found in the various localities selected by different members of this tribe of beings. One of the most anomalous among them is the *Syngamus trachealis*, in which the male is organically blended with the tail of the female, producing a kind of hermaphroditism of a most remarkable description.

V. CLASS.—CAVITARY-PARASITES

(Cœlelmintha.)

Alimentary canal distinct, tubular, with an oral and an anal orifice; mouth without radiating tentacles; body elongated, cylindrical, not divided into segments; sexes distinct. Parasitic in other animals.

1. FAMILY.—*Proboscidean-Worms* (Liorhynchidæ.) Mouth terminal, obtuse, emitting a simple retractile proboscis; body elongated, cylindrical, elastic, tapering posteriorly.
2. FAMILY.—*Spiniferous-Worms* (Cheiracanthidæ.) Oral aperture terminal, bivalve, simple; head beset with simple spines; body cylindrical, elastic, armed at fore-part with palmate spines; tapering posteriorly; tail of male spiral; spiculum simple.
3. FAMILY.—*Hooded-Worms* (Cucullanidæ.) Anal aperture terminal; head or neck covered with a plicate or striated hood; body elongated, cylindrical, obtuse anteriorly, attenuate posteriorly; tail of males straight, pointed, without a bursa at hind end.
4. FAMILY.—*Star-mouthed Worms* (Strongylidæ.) Oral aperture ample, orbicular, surrounded by teeth, papillæ, or cilia; body elastic, cylindrical, tapering anteriorly; tail of males

ending a styliferous bursa, and with a single or double spiculum.

5. Family.—*Hermaphrodite-Worms* (Syngamidæ). Oral aperture terminal; body moderate, subcylindrical; male animal organically blended with female by its caudal extremity.
6. Family.—*Round-Worms* (Ascarididæ). Oral aperture terminal, small, covered and concealed by three rounded valvular lips; body cylindrical, elongated, tapering at each end.
7. Family.—*Slender-headed Worms* (Trichocephalidæ). Oral aperture very small, punctiliform, at the end of a very slender non-retractile peduncle or neck; body elongated, cylindrical posteriorly, gradually thickened and clavate.
8. Family.—*Larval-Worms* (Amblyuridæ.) Oral aperture orbicular, simple or cirrhate; body cylindrical, elastic, sometimes free and natant; head continuous with body; tail subulate, acute or obtuse. Parasitic in aquatic larvæ, or found in stagnant water.
9. Family.—*Guinea-Worms* (Filariidæ.) Oral aperture terminal, small, orbicular; body cylindrical, filiform, of the same thickness throughout, often very long and rigid, extremities obtuse. Parasitic in the skin of man.

POLYPS.

These plant-like animals, sometimes known under the name of Zoophytes, are usually fixed to rocks and stones or other marine bodies at the bottom of the sea; either throwing out numerous branching fronds, spreading laterally in the form of mushrooms, or incrusting the surface in an irregular manner; gradually depositing calcareous matter, previously held in solution by the water, and building up those remarkable coral-reefs and shoals, frequently the cause of dread to mariners, and often, when covered with vegetation, becoming the ocean-abodes of man. The living portion of the bodies of these animals is composed of a transparent or coriaceous covering, which incrusts their horny or calcareous skeletons. This wonderful, gelatinous fabric, though apparently so simple, has yet the vital power of growing, of separating the earthy particles dissolved in the water which surrounds it, and of propagating its kind by means of little buds or gemmules. The higher, or more highly organized, creatures of this Class are not only, however, invested with a living bark, but the surface of their bodies is studded with numerous useful organs called *polyps*, which serve the purpose of stomachs, and which are provided with sensitive tentacles to secure a proper amount of food. Sometimes the entire animal consists of a single, free, and locomotive polyp, as the *Hydra* of the fresh waters; sometimes the polyps are associated together in prodigious numbers, as in the *Alcyonium*, in which the common mass is soft, and in the Madrepores, in which the common basis is calcareous. These latter are especially the animals that propagate their kind upon the crests of mountain-ranges under the sea, on the tops of submarine hills, or round the margins of the craters of submerged volcanoes, forming, by their gradual growth and decay, those "atolls," barrier-reefs, and coral-islands, met with so abundantly in the great Pacific Ocean. The *Actiniæ* are isolated, fleshy polyps, attached to marine bodies by their bases, and with their mouths surrounded with numerous coloured tentacles, which give them, when expanded, the appearance of animal-flowers; hence they have been named "Sea Anemones." The red coral of commerce (*Corallium rubrum*) is obtained principally from the Mediterranean, about the islands of Majorca and Minorca; it is also procured from the Coast of Africa. The *Corallines* of Linnæus are cellular in their microscopic character, and although they resemble the skeletons of polyps, yet belong to the Vegetable Kingdom.

VI. CLASS.—POLYPS (Polypifera).

Animal with a circle of retractile, non-ciliated tentacles surrounding the mouth; stomach simple, with a single orifice; gemmiparous and oviparous.

I. ORDER.—Hydroid-Polyps (Hydroida).

Polyps compound, rarely single and naked; tentacles filiform, roughish; stomach without proper parietes; reproductive gemmules pullulating from the body, and naked or contained in external vesicles. Polypary horny, fistular, external, plant-like.

1. FAMILY. — *Clavate fleshy-Polyps* (Corynidæ). Ovisacs budding from the bases of the tentacles; polyps naked, or with only a rudimentary polypary.
2. FAMILY.—*Fistular-Polyps* (Tubulariidæ). Ovisacs budding from the bases of the tentacles; polyps with the tentacles whorled; polypary fistular, horny, simple, tortuous or ramified.
3. FAMILY.—*Plant-like Polyps* (Sertulariidæ). Ovisacs in the form of horny, deciduous capsules, scattered on the polyparies; polyps with simple tentacles lodged in sessile cells; polypary tubular, ramified, and plant-like.
4. FAMILY.—*Bell-bearing Polyps* (Campanulariidæ). Ovisacs in the form of horny, deciduous capsules, scattered on the polyparies; polyps with a simple series of tentacles; polyp-cells on ringed stalks, terminal, campanulate; polypary horny, plant-like.
5. FAMILY.—*Freshwater-Polyps* (Hydridæ). Propagation by buds and ova, which develope themselves on and in the body of the parent. Polyps locomotive, free, single, naked, gelatinous, with long, simple tentacles.

II. ORDER.—ZOANTHOID-POLYPS (Zoanthoida).

Polyps single, free or fixed, fleshy, naked, or with calcareous polyparies with radiating lamellæ; tentacles tubular; stomach membranous, plaited; oviparous; ovaries internal.

1. **Family.**—*Sea-Anemones* (Actiniidæ). Polyps fleshy, soft, separate, single; ovi-viviparous; mouth with several rows of simple or branched tentacles.
2. **Family.**—*Lucernarians* (Lucernariidæ). Polyps companulate, fixed by a narrow stalk, in the centre of an umbrellar expansion; tentacles in tufts.
3. **Family.**—*Animal-Flowers* (Zoanthidæ). Polyps coriaceous, incrusted or solidified by foreign bodies; gemmiparous; associated by a common base.
4. **Family.**—*Pocillopores* (Pocilloporidæ). Polypary solid, spinulose or granulated; polyp-cells circumscribed, ridged, 6-sided, shallow, ciliated or spinulose; polyp with few tentacles, in a single series.
5. **Family.**—*Stylasters* (Stylasteridæ). Polypary minutely porous; polyp-cells deep, cylindrical, with six grooves, each ending in a pore and a central style; polyp with few tentacles, in a single series.
6. **Family.**—*Madrepores* (Madreporidæ). Polypary spongy, porous, rough; coral cells deeply circular, with 6 or 12 longitudinal folds, immersed or produced, sub-cylindrical, without any central style; tentacles in a single series.
7. **Family.**—*Porites* (Poritidæ). Polypary very porous, spongy, rough; polyp-cells many-

sided, with granulose edges, more or less incomplete; spinous lamellæ, surrounded by pierced or netted parietes; polyps with a single series of tentacles.

8. Family. — *Dendritic-Corals* (Dendrophylliidæ). Polypary hard, porous; surface minutely longitudinally striated; polyp-cells with a single centre, truncated, concave, generally with a convex centre; polyp with numerous tentacles in several series; gemmiparous.

9. Family. — *Eyed-Corals* (Oculinidæ). Polypary hard, covered with enamel; coral-cells with a single centre, concave, with radii extended over the edges, or with the outer edge radiately ground; polyp with numerous tentacles in two or more series; gemmiparous.

10. Family. — *Starred - Corals* (Caryophylliidæ). Polypary hard, with an enamelled surface; polyp-cells with many centres, or confluent, deep, round; laminæ torn, serrated, with a twisted centre, often with intermediate smaller plates not reaching the centre; polyp with numerous tentacles, in two or more series; gemmiparous.

11. Family.—*Brainstone - Corals* (Mæandrinidæ). Polypary hard; cells confluent, deep, elongate, compressed, with a single series of equal laminæ forming a single, linear, impressed line in the centre; polyp with numerous tentacles in two or more series; growing by spontaneous division.

12. **Family.**—*Mushroom-Corals* (Agariciidæ). Polypary hard; polyp-cells shallow, not circumscribed, but scattered and united to one another by laminæ on the star-bearing surface of the coral; animal growing laterally, forming a leaf-like frondose mass.

III. ORDER.—Asteroid-Polyps (Asteroida).

Polyps compound; tentacles eight, fringed; stomach membranous, with internal appendages; ovules produced interiorly; polypary free or fixed, fleshy, strengthened by a horny or calcareous axis, covered with a gelatinous crust.

1. **Family.**—*Alcyonians* (Alcyoniidæ). Polypary fixed, coriaceous or fleshy, strengthened with calcareous spicula; polyp-cells subcutaneous, scattered over the surface.
2. **Family.** — *Sea-Pens* (Pennatulidæ). Polypary free, pennate, fleshy; axis bony, simple, continuous; skin spiculiferous; polyps with eight pinnate tentacles, arranged along margin of pinnæ.
3. **Family.** — *Umbellate - Corals* (Umbellulariidæ). Polypary free, simple, elongated, with the polyps at the summit; axis stony, inarticulate, covered with a fleshy cortex; polyps large, terminal, arranged in an umbellate manner at the end of the polypary.
4. **Family.**—*Calcareous-Corals* (Coralliidæ). Polypary fixed, arborescent, calcareous; covered

with a fleshy cortex; polyps prominent, scattered over the whole surface.

5. FAMILY.—*Horny-Corals* (Antipathidæ). Polypary fixed, ramose; axis horny, solid, flexible; cortex gelatinous, disappearing when dried; polyps prominent, scattered over the entire surface.

6. FAMILY. — *Sea-Fans* (Gorgoniidæ). Polypary fixed, branching, often reticulate; axis horny, solid, flexible; cortex thick, firm, porous, cretaceo-gelatinous, persistent when dried; polyps scattered over the whole surface.

7. FAMILY.—*Arragonite-Corals* (Briareidæ). Polypary branched, formed of large, transparent, rough, fusiform spicula, regularly placed side by side along the stems, embedded in the cortex, cortex covered with large conical tubercles.

8. FAMILY. — *Glass-Rope Corals* (Hyalonemidæ). Axis composed of a congeries of siliceous filaments, slightly twisted together in the form of a rope, covered with a coriaceous tuberculated cortex; tubercles depressed, scattered.

9. FAMILY.—*Incrusting-Corals* (Clavulariidæ). Polypary in the form of a thin flattened mass, covering marine objects; polypi non-retractile, with eight pectinate tentacles, prominent, close together on the surface.

10. FAMILY.—*Organ-Corals* (Tubiporidæ). Polypary composed of calcareous tubes arranged in stages like the pipes of an organ; polyps terminal, in the mouths of the tubes.

11. FAMILY.—*Horn-like Corals* (Cornulariidæ) Polypary horny, fixed, composed of small horn-like conical tubes, erect, each containing a single terminal solitary polyp, with eight dentato-pinnate tentacles.

PARENCHYMATOUS-PARASITES.

The Parenchymatous Worms of Cuvier, or the *Sterelmintha* of Owen, are much more simple in their structure than the Cavitary or Cœlelminthous Parasites, their intestinal canal not being provided with distinct walls, and their nervous system being very faintly developed. They are nourished by the juices of other animals, within whose bodies they take up their abode. On this account their digestive organs are very simple; there is no trace of locomotive organs or even of muscles, and the senses are reduced to a single diffused and general sense of touch.

These parasitic worms are found infesting man and the lower animals, inhabiting various tissues and parts of the body, as the eyes of fishes, the brains of sheep, the muscles, the air-passages, the liver, the blood, and the alimentary canal. Among the Cystiform families we find the Hydatids, which resemble transparent bladders filled with fluid, with mouths at the small end furnished with little hooks and suckers. The common species, sometimes found in man, is the *Cysticercus tenuicollis;* another pernicious parasite, well known to farmers as the cause of the fatal disease termed "staggers" in sheep, is the *Cœnurus cerebralis*, and is found in the brain. One very curious form, *Trichina spiralis*, has been discovered embedded in the muscles of the human frame; the *Tœnia solium* is the species of Tape-worm most frequently met with in the intestinal passages of man; and another pest belonging to the same class is the Fluke (*Fasciola hepatica*) which infests the livers of sheep and other ruminating animals, and causes the destructive malady named the "rot." The *Vertumnus thethydicola* is an example of the propriety of changing the name of *Entozoa* into "Parenchymatous-Parasites," for, although in structure it agrees with the other animals of the class, it does not live in the interior, but is parasitic on the skin of a Nudibranch Mollusk, the *Thethys fimbriata*.

VII. CLASS.—PARENCHYMATOUS-PARASITES (Sterelmintha.)

Alimentary canal ramified in substance of animal, with only one aperture, oral and anal; mouth without radiating tentacles; sexes mostly united. Parasitic in other animals.

I. ORDER.—Hook-Worms (Acanthocephala.)

Body cylindrical or sacciform; mouth in form of a retractile proboscis, armed with recurved hooks; sexes distinct.

1. Family. — *Hook - Worms* (Echinorhynchidæ.)

Mouth with a single, terminal, retractile proboscis, armed with recurved hooks; body elongate, cylindrical, sac-like.

II. ORDER.—Cestoid-Worms (Cestoidea).

Body often flattened, sometimes composed of a number of segments; mouth variously armed with hooks and suckers.

1. Family.—*True Tape-Worms* (Tæniidæ). Head with four, lateral, suctorial pits; neck elongated; body composed of numerous segments united together in a linear series.
2. Family.—*Armed Tape-Worms* (Bothryocephalidæ). Head with a single suctorial pit on each side; pits simple, or furnished with suckers extended into filaments; body divided into numerous segments arranged in a linear series.
3. Family.—*Spiny-headed Worms* (Acanthocephalidæ). Head with a large suctorial pit on each side, with two or four retractile trunks armed at the end with hooks or simply papillary; body short, sac-like, not divided into distinct segments.
4. Family.—*Strap-Worms* (Ligulidæ). Mouth a little below the larger anterior extremity, armed with moveable hooks on each side.
5. Family.—*Tricuspid-Worms* (Tricuspidariidæ). Mouth sub-terminal, bilabiate, armed on each side with two tricuspid hooks; body elongate, sub-articulate posteriorly.

III. ORDER.—SUCTORIAL-WORMS (Trematoda).

Body flattened, more or less oval, with one or more prehensile disks on various parts; mouth terminal, in form of a circular sucking disk.

1. FAMILY.—*Flukes-proper* (Fasciolidæ). Mouth with a single terminal sucker; body soft, oblong, depressed, tapering, with posterior ventral prehensile disk.
2. FAMILY. — *Diplostome-Flukes* (Diplostomidæ). Mouth with a single terminal sucker, body flat or sub-cylindrical, with two suckers on lower surface, and a purse-like appendage at hind part.
3. FAMILY. — *Fringed-Flukes* (Caryophyllidæ). Mouth bilabiate, surrounded by a fimbriated, contractile, dilated disk; body soft, elongated, tapering posteriorly.
4. FAMILY.—*Tailed-Flukes* (Cercariidæ). Mouth a simple suctorial disk, with a smaller sucker behind it; body with a long posterior caudal appendage, which can be readily cast off by the animal.
5. FAMILY.—*Proboscidean-Flukes* (Tetrarhynchidæ). Head with four retractile proboscidiform suckers; body sack-like, subclavate, anteriorly obtuse, tapering behind.
6. FAMILY.—*Eared-Flukes* (Scolecidæ). Mouth terminal, encircled by four plicate, sub-perforate, ear-like suckers; body gelatinous, elongate, sub-depressed, contractile, anteriorly clavate, posteriorly acuminate.

7. FAMILY.—*Polystome - Flukes* (Polystomatidæ). Mouth with six, bilocular, biperforate suckers, placed beneath anterior extremity; body elongated, depressed, not segmented, constricted anteriorly, ending in a point behind.

IV. ORDER.—VESICULAR-WORMS (Cystica).

Body cystiform, filled with fluid; mouth furnished with suckers, hooks, or filaments.

1. FAMILY.—*Hydatids* (Hydatidæ). Body round or oblong; mouth with four suckers, armed with a hooked crown.
2. FAMILY.—*Horned-Hydatids* (Ditrachyceratidæ). Body ovate, compressed; anterior extremity furnished with two long horns and filaments.

ACRITE-ANIMALS.

The Sub-kingdom of *Radiata* of Cuvier, which nearly corresponds with the *Polyps* of Linnæus, has, from its vast extent, been of late years again sub-divided. It therefore now comprehends the *Radiata* or *Nematoneura* of Owen, which include all the higher forms, or those in which a nervous system can be distinctly traced,—and the *Acrita*, first separated by Macleay, comprising the lowest and most simple forms of animal existence. The characters of Acrite animals being principally negative, nervous matter not having been hitherto detected in their organization, it follows that its constituent classes must vary in number, for as further or more accurate research indicates the separate existence of this system, such animals become entitled to occupy a more advanced position. In the Acrites, animal life exhibits itself in its most primitive type, and shews clearly that corporeal existence does not depend on an assemblage of important viscera, or the possession of numerous nerves and blood-vessels, but that organized matter can live, move, and have being in a most humble and rudimentary form, descending ultimately to a vivified molecule, or a mere microscopic cell endowed with vitality. The majority of the members of this Subkingdom, though often minute, and likely to escape the notice of any but a vigilant observer of nature, are not on that account the less interesting in their developement, habits, or destiny; nor do they the less exhibit the wondrous power and skill of their omnipotent Creator. Destitute of organs of special sense, endowed most feebly even with sensation, shewing hardly any evidence of being possessed of nervous matter, the whole aim and object of their short-spanned lives appears, to our limited minds, to be self-subsistence and the propagation of their race. In the simplest of the class there are scarcely any signs of a digestive cavity, while others more in advance, and more adapted for enjoying the good things of this life, seem to be all stomach and nothing else.

Their number may be truly said to be "Legion," for they are countless. They are found alike inhabitants of all parts of the world, but their especial element is the boundless expanse of waters. Here myriads glide about free to go wherever they will, and, masters over their movements, roam as they list from place to place. Some again, remain more or less in one locality, while to others the power of free motion is denied, and they have, accordingly, to spend the allotted period of their existence fixed in one spot. Most inhabit salt, but a few are found in fresh water.

But innumerable as they are in our times, they are shewn by geological explorations to have been even still more abundant during former periods of the earth's history, their remains being very numerous in certain strata. Such are the fossil madrepores of the chalk system, in which, also, the large isolated masses of flint that so frequently occur, represent, it is believed, old-world sponges. Abundant occupation for palæontologists is supplied by the *Foraminifera* of ancient eras, the number of extinct species already known being very considerable. The "Bergmehl," too, or mountain-meal of Sweden, exhibited to the microscopic eye of Ehrenberg the skeletons of primitive animalcules, which had finished their career long ere man had made his appearance on the scene.

To most of these curious beings it is a matter of comparative indifference if a portion of their frame is lopped off, as they remain quite as lively after the amputation as before. Many indeed, propagate their kind after this fashion, little portions, or buds, being thrown off, which by degrees, grow to be as their parent was before them, and in time contribute their own quota to the numbers of their race by this mode of paring or budding.

In searching for them the naturalist must have his eyes on the alert in every direction. On the sea-shore, attached to rocks, or fastened on sea-weeds, he will reap an ample harvest. Numbers occur in stagnant waters, but here the magnifying assistance of the microscope must be brought into requisition, and the greater its power, the more astounding will be its revelations, strange-shaped, curious-looking creatures being thus brought before our view, whose wondrous forms bear no resemblance to those of higher classes. The Foraminifers, until lately arranged with Mollusks, in accordance with their more primitive organization, here find an appropriate neighbourhood. And lastly, we have the Sponges, the most simply constructed members of the Animal Kingdom,—an ill-used tribe, often rudely rejected both by zoologist and by phytologist; but at present permitted a resting place by the former, and looked upon as composing the humblest order of one great department of nature.

V. SUB-KINGDOM.—ACRITE-ANIMALS (Acrita).

Animal gelatinous, polymorphous, composed of simple nucleated cells, either solitary or aggregated; without distinct nervous fibre, or visceral cavities. Generation either fissiparous or gemmiparous.

INFUSORIAL-ANIMALCULES.

THESE microscopic beings are usually termed "Infusory-Animalcules," which term formerly embraced the Rotifers, and several other kinds of animals, entirely different in their organization. It is now, however, restricted to the present class, characterized by a number of internal sacs or stomachs, which simple feature will at once distinguish them from other minute forms. The *Polygastrica* are all aquatic, some inhabiting the waters of the ocean, and some being found in fresh water. The discoverer of most of them, and the great authority on their history, is Ehrenberg, whose works display extraordinary patience and profound research. The name of "Monad" is often employed to express the lowest grade of organized beings, and with some degree of truth, for their structure is reduced to very simple elements, and they are so minute that a single drop of water may contain five hundred millions of individuals. Some of the *Polygastrica*, as the *Proteus*, change the forms of their bodies in a very surprising manner, appearing under the microscope sometimes as a round atom of jelly, then becoming slender and worm-like, and even throwing out different parts of their body, and assuming shapes enough fully to justify the name bestowed upon them.

These animals appear to have been equally as numerous during the earlier periods of the world's history as they are now: vast deposits of chalk having been ascertained to consist almost entirely of their extinct remains. The Swedish-earth, eaten by the inhabitants mixed with flour, under the name of "Bergmehl," is also entirely composed of their skeletons, which, in the course of ages, have been accumulating so as to form thick and extensive beds.

The *Polygastrica* are either naked or entirely soft and gelatinous, or they are protected by a thin glassy shell, which often varies in form, sometimes constituting a dorsal shield, as in *Euplœa*, and sometimes resembling a bivalve shell, as in the *Naviculæ*. Their organs of progression consist either of delicate filaments, called *cilia*, with which their bodies are covered, or of stiff, moveable, bristle-like organs, or little hooks, which also serve to attach them to foreign bodies. The reproduction of these minute organisms is by means of buds, which sprout from the surface of their bodies, and become, in the course of time, like the parent animals, or by free gemmules, contained in the interior of the mother, whose globular body bursts, and the little ones come forth at the sacrifice of their parent's life. They also increase by spontaneous fissure, so that an old animal may thus renew his youth, by becoming two or more young ones.

I CLASS.—INFUSORIAL-ANIMALCULES (Polygastrica).

Intestinal canal replaced by a number of small, interior cavities; multiply by spontaneous division of their bodies.

I. ORDER.—ANENTEROUS-INFUSORIALS (Anentera).

No internal nutritive tube, nor anal orifice.

I. *SUB-ORDER.*—GYMNICANS (Gymnica).

Body with no external cilia, nor pseudopediform prolongations.

1. FAMILY.—*Monads* (Monadidæ). Without external shell; body uniform, dividing by simple, spontaneous fissure into two or several individuals.
2. FAMILY. — *Shelled-Monads* (Cryptomonadidæ). Individually enveloped in a soft or slightly indurated shell.
3. FAMILY.—*Globe-Animalcules* (Volvocidæ). An external envelope or shell, spontaneously dividing into a number of animals which take the form of a polypary.
4. FAMILY. — *Thread-Animalcules* (Vibrionidæ). Filiform; without shell; associated in filiform chains by means of imperfect transverse spontaneous division.
5. FAMILY.—*Parasitic-Animalcules* (Gregarinidæ). Single, solitary, nucleated cells, without cilia; parasitic in the intestines of many invertebrates, especially insects.
6. FAMILY.—*Closterians* (Closteriidæ). Dividing spontaneously into a baciliform polypary; shell with moveable papillæ in the aperture.
7. FAMILY.—*Astasians* (Astasiidæ). Body with a single aperture, changing at pleasure to caudate, or ecaudate; shell none.

8. FAMILY. — *Shelled-Astasians* (Epipyxididæ). Body with a single aperture, changing the form at will; an external shell.

II. *SUB-ORDER.*—EPITRICHANS (Epitricha).

Body ciliated, or furnished with setæ, without pseudopediform prolongations.

9. FAMILY.—*Disk-Animalcules* (Cyclidiidæ). Body with ciliated appendages; shell none.
10. FAMILY. — *Wreath-Animalcules* (Peridiniidæ). Ciliæ often in the form of a zone or crown; an external shell.

III. *SUB-ORDER.*—PSEUDOPODS (Pseudopoda).

Body with variable pseudopediform prolongations.

11. FAMILY. —*Protean-Animalcules* (Amœbidæ). Body without a shell; furnished with variable processes.
12. FAMILY. — *Capsule-Animalcules* (Arcellidæ). Body with changeable appendages; enclosed in an urceolate or scutellate shell.

II. ORDER.—ENTERODELOUS-INFUSORIALS (Enterodela).

An internal digestive canal, provided with a mouth, and an anal opening.

I. *SUB-ORDER.*—ANOPISTHIANS (Anopisthia).

Mouth and anus contiguous.

1. FAMILY. — *Bell - Animalcules* (Vorticellidæ). Without shell; developing by imperfect spontaneous division; free and solitary, or fixed and associated.

2. FAMILY.—*Loricated Bell-Animalcules* (Ophrydiidæ). Animal loricated; solitary or aggregated; with a shell.

II. *SUB-ORDER.*—ENANTIOTRETANS (Enantiotreta).

Mouth and anus terminal, and opposite; reproduction by transverse division.

3. FAMILY. — *Rolling-Animalcules* (Enchelidæ). Without a shell.
4. FAMILY.—*Box-Animalcules* (Colepidæ). Loricated, or furnished with a shell.

III. *SUB-ORDER.*—ALLOTRETANS (Allotreta).

Mouth and anus terminal and opposite; reproduction by longitudinal and transverse division.

5. FAMILY.—*Neck-Animalcules* (Tracheliidæ). Anal opening alone terminal; without a shell.
6. FAMILY.—*Swan-Animalcules* (Trachelocercidæ). Oral opening only terminal; without a shell.
7. FAMILY. — *Shield-Animalcules* (Aspidiscidæ). Anal opening only terminal; with a shell.

IV. *SUB-ORDER.*—KATOTRETANS (Katotreta).

Mouth and anus not terminal; reproduction by longitudinal and transverse division.

8. FAMILY. — *Breast-Animalcules* (Colpodidæ). Without a shell; neither opening terminal.
9. FAMILY. — *Hackle-Animalcules* (Oxytrichidæ). Without a shell; with vibrating cilia, and with non-vibrating styles or uncini.
10. FAMILY.—*Boat-Animalcules* (Euplotidæ). With a shell; neither orifice terminal.

FORAMINIFERS.

These singular animals until recently were regarded as a distinct order of Cephalopodous Mollusks, which the polythalamous nature, and general appearance of their small shell-like skeletons, seemed to authorize. Although the organization of the vital portion of their bodies appears so simple, yet these little nautiloid shells are remarkable not only for their beauty and varied forms, but for a certain degree of complexity in their structure. Minute as are the *Foraminifera,* they yet are powerful auxiliaries to the coral-forming *Polypifera,* in building up islands in the middle of the ocean, in obstructing navigable channels, and in gradually filling up bays and harbours. They are found in the greatest abundance on the sandy shores of tropical countries, although very numerous forms are met with on our own coasts. Nine hundred species belonging to sixty-eight genera, have been described by D'Orbigny, from existing seas, and it would appear that in the fossil state they are no less numerous, the same eminent naturalist having discovered and recorded thirty genera, consisting of two hundred and fifty species in the Cretaceous formation only. In order to render their forms obvious to the eye of the casual observer, M. D'Orbigny made exquisite models on a large scale of the different genera, copies of many of which, in plaster of Paris, may be observed in the British Museum.

II. CLASS.—FORAMINIFERS (Foraminifera).

Animal bursiform, simple, gelatinous, without appreciable organization, but secreting a delicate, many-celled, internal, calcareous skeleton, into the cells of which the animal can retract; mouth central, surrounded by retractile, tentacular processes, which constantly vary in form, and which serve for swimming and crawling.

1. FAMILY.—*Straight-Foraminifers* (Vaginulidæ) Shell many-celled, with the cells placed end to end in a single series in a straight or slightly curved form.
2. FAMILY.—*Alternating-Foraminifers* (Textulariidæ). Shell many-celled, with the cells disposed alternately in two or three parallel series, but without forming a regular spiral.
3. FAMILY.—*Spiral-Foraminifers* (Discorbidæ). Shell many-celled, with the cells arranged in a single series, but forming a regular spiral, which is discoidal or turriculate.
4. FAMILY.—*Imbricated-Foraminifers* (Miliolidæ). Shell with the cells variously clustered and imbricate, and each rolled round a common axis; aperture usually furnished with an appendage.
5. FAMILY.—*Compound-Foraminifers* (Orbiculinidæ). Shell with the cells divided into several smaller cavities by small tubes, or by partitions.

6. FAMILY.—*Pelagic-Foraminifers* (Thalassicollidæ). Shell, when present, transparent, brittle, either perforated by numerous rounded apertures, or with the apertures prolonged into short tubes.

SPONGES.

The Sponges, although they have been claimed as the property both of the Phytologist and Zoologist respectively, are, at present, usually regarded as members of the Animal Kingdom, though their claims to this distinction are certainly not very obvious. No indication of sensation has been detected in their amorphous bodies: in fact they cannot be said to feel as much as many undoubted vegetables. They have no stomach or receptacle for food, usually regarded as the *"sine qua non"* of an animal, for their substance is permeated by canals, which convey the water, in which their nourishment is dissolved, to every part. The Sponges, however, differ from plants, in giving out, when burned, a smell resembling burnt horn, which indicates the presence, in considerable abundance, of nitrogen in their composition. Their more animal part is a thin, transparent, gelatinous layer which invests the complicated tissue of horny fibres usually known under the name of "Sponge," but which is in reality the skeleton of these animals. The Sponges of commerce are obtained in considerable quantities from the Mediterranean, and are usually prepared by soaking in dilute hydrochloric acid, in order to remove all traces of lime, and then bleached and well-beaten, to render them fit for the market; but the greater majority of Sponges are unfit for useful purposes, on account of the large amount of siliceous and calcareous spicula with which their skeletons are strengthened. Although the portions of a Sponge, when cut in half, will each grow and become perfect sponges, yet their usual mode of propagation is by means of gemmules, which sprout from the delicate granular film covering their skeleton; and which, gradually becoming detached from the parent body, are furnished with cilia, swim freely about, and afterwards, finding a favourable locality, become fixed, and gradually enlarge into Sponges.

III. CLASS.—SPONGES (Porifera).

Body multiform, fixed, fleshy, composed of a fibrous axis, covered with a gelatinous coating; often interwoven with siliceous or calcareous spicula. Reproduction by gemmules.

I. ORDER.—HORNY-SPONGES (Cornea).

Body very porous and elastic, soft, composed of a fibro-corneous skeleton, which anastomoses in all directions; without any spicula.

1. FAMILY.—*Sponges-proper* (Spongiidæ). Body irregular, traversed by tortuous canals, opening externally by distinct oscula.

II. ORDER.—SILICEOUS-SPONGES (Silicea).

Body more or less rigid or friable, and strengthened with siliceous spicula.

1. FAMILY.—*Thethyan-Sponges* (Thethyidæ). Body irregular, tuberiform, sarcoid, firm; spicula fasciculate, and diverging from the centre to the circumference.

III. ORDER.—CALCAREOUS-SPONGES (Calcarea).

Body not very soft, composed of a sub-cartilaginous substance, supported by calcareous spicula.

1. FAMILY.—*Grantian-Sponges* (Grantiidæ). Body more or less solid, irregular, traversed by tortuous canals, terminating by oscula over the whole surface.

In finally revising the divisions of the Animal Kingdom, we considered it advisable to alter somewhat the arrangement as given at page 4. We have therefore subjoined the order which we have adopted in the preceding pages, in which, instead of endeavouring to approximate connecting links between the different Sub-kingdoms, we have placed the Classes of the five primary divisions in linear, graduated series, commencing in each with the most highly developed. Several additional synonymes have also been added for the sake of reference.

CLASSIFICATION OF THE ANIMAL KINGDOM.

I.—SUB-KINGDOM. VERTEBRATE-ANIMALS.

Vertebrata, *Cuv.* Osteozoa, *Blainv.* Spinicerebrata, *Grant.* Myelencephala, *Owen.*

1	Class *Mammals*	(Quadrupedes - vivipari, *Gesn.* Mammalia, *Lin.* Mammifera, *Cuv.*)	Hæmatherma, *Latr.* Vertébrés - allantoidiens, *M. Edw.*	
2	„ *Birds*	(Aves, *Lin.*)		
3	„ *Reptiles*	(Reptilia, *Lin.* Scleroderma, *Kirby.*)	Pulmonea, *Latr.* Amphibia (pars), *Lin.* Quadrupedes-ovipari, *Gesn.*	Hæmacryma, *Latr.* Vertébrés-anallantoidiens, *M. Edw.*
4	„ *Amphibians*	(Amphibia, *Latr.* Batrachia, *Brongn.* Malacoderma, *Kirby* Dipnoa, *Leuck.*)		
5	„ *Fishes*	(Pisces (pars), *Lin.* Solibranchia, *Latr.* Poissons, *Lacep.*)		

II.—SUB-KINGDOM. MOLLUSCOUS-ANIMALS.

Testacea, Mollia, *Pliny.* Vermes (pars), *Lin.* Mollusca, *Cuv.* Gasterozoa, *Carus.* Malacozoa, *Blainv.* Cyclogangliata, *Grant.* Heterogangliata, *Owen.*

1	Class *Cephalopods*	(Cephalopoda, *Cuv.* Antliobrachiophora, *Gray*)	Pterygia, *Latr.*	Cephalophora, *Blainv.*	Mollusca, *Lam.*
2	„ *Pteropods*	(Pteropoda, *Cuv.* Aporobranchiata, *Blainv.* Stomatopterophora, *Gray.*)			
3	„ *Gasteropods*	(Gasteropoda, *Cuv.* Trachelipoda, *Lam.* Gasteropodophora, *Gray.*)			

4 Class *Bivalves* ....(Conchifera, *Lam.*
Lamellibranchiata, *Blainv.*
Conchophora, *Gray.*
Tropiopoda, *Macgill.*
Dithyra, *Aristotle.*)
5 „ *Brachiopods* ......(Brachiopoda, *Cuv.*
Palliobranchiata, *Blainv.*
Spirobrachiophora, *Gray.*)
6 „ *Tunicaries* ......(Tunicata, *Lam.*
Ascidia, *Lin.*
Heterobranchiata, *Blainv.*
Apoda, *Macgill.*)

Acephalophora, *Blainv.*

III.—SUB-KINGDOM. ANNULOSE-ANIMALS.

Insecta et Vermes (pars), *Lin.* Articulata, *Cuv.* Annulosa, *Macleay.* Entomozoa, *Blainv.* Diplogangliata, vel Entomoidea, Diploneura, *Grant.* Homogangliata, *Owen.*

1 Class *Insects*............(Insecta, *Goldfuss.*
Hexapoda (pars), *Latr.*
Ptilota, *Aristotle.*
2 „ *Aiolopods* ......(Aiolopoda, *nobis.*)
3 „ *Arachnidans* ...(Arachnida, *Macleay.*
Arachnides, *Lam.*
Arachnoida, *Leach.*
Unogata, *Fabr.*)
4 „ *Crustaceans* ...(Crustacea, *Cuv*).
5 „ *Cirrhopods*......(Cirrhopoda, *Cuv.*
Cirripeda, *Leach.*
Cirripedea, *Macleay.*
Nematopoda, *Blainv.*
Lepas, *Lin.*)

Aptera (pars), *Aristotle.*

Insecta (pars), *Lin.*

6	Class	*Fish-Parasites*	(Epizoa, *Blainv.* Siphonostomata, *Latr.*)
7	„	*Annelids*	(Annelida, *Macleay.* Annulida, *Grant.* Annulosa, *Latr.*) Annellides, *Lam.* Annulata, *M. Edw.*)

IV.—SUB-KINGDOM. RADIATE-ANIMALS.

Centroniæ, *Pallas.* Vermes (pars), *Lin.* Zoophyta, *Cuv.* Animaux apathiques (pars), *Lam.* Radiata (pars), *Flem.* Actinozoa, *Blainv.* Diploneura vel Helminthoidea (pars), et Cycloneura (pars), *Grant.* Nematoneura, *Owen.*

1	Class	*Echinoderms*	(Echinodermata, *Cuv.* Cirrhodermata, *Blainv.*)	Radiaria, *Lam.*
2	„	*Sea-Nettles*	(Acalephæ, *Cuv.* Arachnodermata *Blainv.* Malactinia, *Grant.*)	
3	„	*Rotifers*	(Rotifera, Infusoria (pars), *Cuv.* Rotatoria, *Ehr.* Systolides, *Sieb.*)	
4	„	*Ascidian-Polyps*	(Polyzoa, *Thomp.* Bryozoa, *Ehr.* Ciliobrachiata, *Farre.*)	
5	„	*Cavitary-Parasites*	(Cœlmintha, *Owen.* Nematoidea, Entozoa (pars), *Rud.* Vers-rigidules, *Lam.*)	
6	„	*Polyps*	(Polypifera, *Grant.* Anthozoa, *Ehr.* Phytozoa, *Brandt.* Zoophyta, *Gray.*)	

7 Class	*Parenchymatous-Parasites*	(Sterelmintha, *Owen*. Vers-molasses, *Lam.* Entozoa (pars), *Rud.*)

V.—SUB-KINGDOM. ACRITE-ANIMALS.

Radiata (pars), *Flem.* Cryptoneura (pars), *Rudolphi.* Animaux apathiques (pars), *Lam.* Cycloneura (pars), *Grant.* Acrita, *Macleay.* Oozoa, *Carus.* Protozoa, *Oken.*

1 Class	*Infusorial-Animalcules*	(Infusoria (pars), *Lin.* Polygastrica, *Ehr.* Agastria, *Blainv.*)
2 „	*Foraminifers*	(Foraminifera, *D'Orb.*)
3 „	*Sponges*	(Spongia, *Lin.* Porifera, *Grant.* Amorphozoa, *Blainv.*)

PART II.

PHYTOLOGY.

THE NATURAL FAMILIES OF THE VEGETABLE KINGDOM, ARRANGED ACCORDING TO THEIR ORGANIZATION.

THE extreme importance of the Vegetable Kingdom to mankind, the great beauty of some of its members, the graceful proportions, or the singular construction of others, have rendered it an object of engrossing attention from very remote times. As knowledge spread and civilization increased, the rude acquaintance possessed by early races with useful fruits and herbs, gradually increased into a special study for ancient sages and philosophers. Among the Greeks it was pursued by Hippocrates and Aristotle, by Theophrastus and Dioscorides, and in the western world it ranked among the scientific acquirements of the elder Pliny. Nor was it deemed unworthy of the attention of the wisest of men, for it is recorded in Sacred writ that Solomon, King of Israel, spoke of trees, from the cedar-tree upon Lebanon, unto the hyssop that sprung out of the wall. Nearer our own times it numbered among its cultivators the industrious Gesner, Turner, the father of English Botany, quaint old Gerard the herbalist, the philosophic Ray, the learned Tournefort, and finally it took a lasting stand on a fixed and sure basis under the presiding genius of the illustrious Scandinavian Linnæus. Since his era it has occupied a high place among the natural sciences, having been further advanced by the labours of such men as Jussieu, Decandolle, and Smith; while among those still living, it may not be invidious to mention the veteran Robert Brown, "Botanicorum facile princeps."

Phytology, or the study of plants and their products, embraces the consideration of the whole Vegetable Kingdom, and treats of the distribution, the conformation, the properties, and the classification of trees, shrubs, and herbs, from the minute lichen, or simple floating weed, to the gracefully waving palm or lofty mountain pine. The latter of these, or classification, which will chiefly engage attention in the following pages, is founded mainly on external characters, although, more especially of late years, differences in internal structure are likewise taken into account. Omitting mention of earlier more primitive plans, the first division which obtained great reputation was the celebrated artificial arrangement of Linnæus, which, from its simplicity, and the comparative facility of its application, gained a wide-spread popularity. But, after a time, when its novelty had worn off, complaints began to be made of its limited nature, as in the absence of the parts of fructification, the class or order of a plant could not be determined. Hence arose a cry for a natural classification, which, indicated by Ray, and acknowledged by Linnæus, was first given to the world in a detailed form by Antoine Laurent de Jussieu, in 1789. His system has since been variously modified by different writers, of whom the most recent is Lindley, whose views are here chiefly followed. We have restored to the "orders" of the last named writer, their original designation of families, while his "alliances" are our orders, as it only, we believe, tends to confuse when we find phytological and zoological groups of equal value differing in their mode of nomenclature. In other respects, however, we have adopted nearly throughout, the uniform system of termonology employed in the last edition of the "Vegetable Kingdom."

Scarcely any branch can be more universally attended to by the travelling naturalist than that of Phytology. Wherever he bends his way he will almost certainly discover, in some form or another, vegetable existences. Water and land alike teem with herbaceous productions, the former being either marine or fresh-water. Among the latter will be found numerous aquatic species, both floating and submerged, while the scum on the surface of ponds and stagnant pools, will under the microscope, exhibit various primitive forms of vegetable life. On the sea-shores, and extending thence outwards to various depths, will be seen numerous varieties of marine *Algæ*, and away from the land, often in the midst of the ocean, floating masses of sea-weed are frequently met with, which are likewise at times the abodes of pelagic Crustaceans, and other animals. On terra-firma every country has its own peculiar plants, which vary from the luxuriant vegetation of the valleys, to the bleak and barren wilds of alpine regions, or from the thickly-set forests of the tropics to the frigid ice-clad rocks of arctic or antarctic climes. No country is yet known to be entirely destitute of herbage. Melville Island, Novaya Zemlya, and Spitzbergen, in the far north, as well as Tierra del Fuego, and the lately-discovered lands of the extreme south, alike yield their contributions; even from Kerguelen's-land, that Isle of Desolation, a limited Flora has been compiled by the younger Hooker.

Vegetables play a most important part in the economy of our globe. Not only do they yield abundant aliment for man and beast, for insect and worm, but also by absorbing carbon from the atmosphere they purify it and render it fit for respiration; their ashes also, and other debris form the basis of a rich soil, which especially in new countries is of vast importance. Coals and other bituminous minerals, which are the fossilized remains of primeval forests, are too well known as most valuable agents in the hands of man, to be more than mentioned. In short, whether clothing the plain, adding beauty to the landscape, or magnificence to the mountain, whether charming the eye, or pleasing the imagination, affording raiment, food, or medicine, or employed in the arts or sciences, they equally point to the great first cause, whose omniscience renders all his works subservient to good,—

> "Where order in variety we see,
> And where, though all things differ, all agree."

CLASSIFICATION OF THE VEGETABLE KINGDOM.

I.—SUB-KINGDOM. FLOWERING-PLANTS.

Phanerogamia, *Lin.* Vasculares, *De Cand.* Heterorgana, *Schultz.* Sexuales *Lindl.*

1 Class *Exogens*	(Anthophytæ, *Oken.* Dichorgana, *Schultz.* Phylloblastæ, *Reichen.* Synechophyta, *Schleid.* Exogenæ, *Lindl.*)	Dicotyledones, *Juss.* Exogenæ, *De Cand.* Acramphibrya, *Endl.*		
2 ,, *Gymnogens*	(Synorhizæ, *Rich.* Gymnospermæ, } *Lindl.*) Gymnogenæ, }			
3 ,, *Dictyogens*	(Retosæ, } *Lindl.*) Dictyogenæ, }	Monocotyledones, *Juss.* Amphibrya, *Endl.*	Endogenæ, *De Cand.*	
4 ,, *Endogens*	(Endorhizeæ, *Rich.* Synorgana, *Schultz.* Teleophyta, *Schleid.* Endogenæ, *Lindl.*)			
5 ,, *Rhizogens*	(Rhizantheæ, *Blum.* Acrobrya (pars), *Endl.* Evasculares, } Sporogenæ, } *Lindl.*) Rhizogenæ, }			

II.—SUB-KINGDOM. FLOWERLESS-PLANTS.

Cryptogamia, *Lin.* Acotyledones, *Juss.* Cellulares, *De Cand.* Homorgana, *Schultz.* Esexuales, *Lindl.*

1	Class *Acrogens*	(Pseudocotyledoneæ, *Agardh.* Heteronemea, *Fries.* Hysterophyta, Acrobrya (partim), *Endl.* Cormogenæ, *Lindl.* Acrogenæ, *Brongn.*)
2	„ *Thallogens*	(Acotyledoneæ, *Agardh.* Homonomea, *Fries.* Cryptophyta, *Link.* Thallophyta, Protophyta, *Endl.* Amphigenæ, *Brongn.* Thallogenæ, *Lindl.*)

FLOWERING-PLANTS.

Among Vegetables, Sub-kingdoms cannot be defined or limited with the same precision and accuracy as among animals, for the nervous system, of which the different modes of distribution serves so well as the basis of primary divisions in the latter, is totally wanting in the other, nor do they possess any other tissue which can adequately supply its place. Some systematical writers, indeed, discard the separation into Sub-kingdoms altogether, and proceed at once to Classes, Sub-classes, and Orders. But without laying too much stress on such divisions, they seem to be naturally indicated, and are found useful for purposes of study, and accordingly two such have been established, which are determined by the presence or absence of flowers, and of distinct organs of fructification. The first of these, variously named the Flowering, Sexual, or Phanerogamic, is the highest in the scale, and contains all the more important species. As a general rule, its members attain a much larger size, and are in all respects more fully developed. They possess vascular as well as cellular tissue, or, as these are technically expressed, "parenchyma," and "angienchyma;" they all have distinct sexual organs, either in the same or in different individuals, that is to say, they are either hermaphrodite or unisexual; and finally they are propagated by seeds. They compose nearly six-sevenths of the total number of genera and species at present known, the comparative proportion being greatest within the tropics, and diminishing towards the poles.

Flowers have been arranged according to their colour in three series, viz., white, xanthic, and cyanic, the first including all the pale coloured kinds, the second comprehending the yellows and scarlets, and the third comprising the blue and the purple varieties. The white abound more in northern situations and alpine regions, the xanthic are more common in the tropics, especially during the autumn, while the cyanic flourish in the congenial climates, and under the clear blue skies of warmer parts of temperate latitudes.

Almost all the vegetable products employed by man are yielded by this Sub-kingdom, which likewise affords abundant food for the lower animals, comprehending trees of all kinds, as the Oaks, the Sycamores, the Beeches, the Pines of temperate climes,—also the Baobabs, the Palms, the Cycads of the tropics,—all fruit-producing species,—culinary, and other edible herbs,—the tea, coffee, and cocoa plants,—the sugar-cane,—the cereal grains, and all grasses,—and in fine, almost all plants yielding drugs, gums, resins, or other economical agents.

1.—SUB-KINGDOM.—FLOWERING-PLANTS (*Phanerogamia*).

Flowers (variously modified) present; fructification mostly springing from a stem; reproductive organs distinct; propagate by seeds; sexes in the same or in different individuals.

EXOGENS.

Exogenous plants constitute the most numerous class, not only of the *Phanerogamia*, but of the whole Vegetable Kingdom, comprising upwards of six thousand genera, and not fewer than sixty-six thousand species. They are in all respects the most advanced forms of vegetable life, their organization being more complex, their vitality more intense, and their powers of endurance and length of life more extended. They derive their name from the manner in which the woody tissue is formed, new matter being annually added from *without*, which from year to year gives the look of a series of concentric rings in a transverse section of the trunk. The centre is occupied by a lighter tissue, named "pith," while the exterior is covered with bark, which is renewed annually by fresh matter from within, or on that surface which is in contact with the true wood. The appearance of a cross section of a stem presents, as just mentioned, concentric rings, varying in number according to the age of the individual, which are again crossed at right angles, by lines radiating from the centre. To this, however, there are many exceptions; in some the radii are wanting, in others there is but a single ring, or there may be irregular layers of cellular tissue between the woody zones. These have been proposed by Lindley to be placed in a separate class, to which the name of "Homogens" has been assigned, but this idea, though apparently founded on sound principles, has not yet been worked out. Exogens were by De Candolle styled *Dicotyledones*, from the seed being composed of two cotyledons. The different parts of the flower are generally either five or some multiple of that number; occasionally, however, four is the primary number, and in some rare cases three.

Various methods have been proposed for arranging this class. Some adopt as the basis of their division the existence or non-existence of distinct floral envelopes, the former being divided into monopetalous and polypetalous. Slightly differing from this is the plan of De Candolle, who named his divisions *Thalamifloræ*, *Calycifloræ*, *Corollifloræ*, *and Monochlamydeæ.* In the succeeding pages we shall employ a slight modification of the scheme offered by the learned author of the "Vegetable Kingdom," who, considering that the parts of fructification are the most important floral organs, has founded his classification on their distribution and relative situation, and accordingly has established four sub-classes, viz., Diclinous, Hypogynous, Perigynous, and Epigynous Exogens. But we consider that the last three, not being equivalent in value to the first, must be rejected as sub-classes, and continued merely as inferior divisions. The great distinction among Exogens, being the Hermaphrodite or Unisexual nature of the flowers, indicates two primary sections, the one Diclinous, and the other Monoclinous or bisexual. The latter may be satisfactorily arranged according to the position of the stamens into Hypogynous, Perigynous, and Epigynous alliances, which principle might possibly be extended to the other sub-class. Arranged therefore in a diagram they appear, thus, in descending series.—

1. Sub-class *Bisexual Exogens*.........Monoclineæ.
    1. Hypogyneæ.
    2. Perigyneæ.
    3. Epigyneæ.
2. „ *Unisexual Exogens* ......Diclineæ.

I.—CLASS EXOGENS (Exogenæ).

A cellular and a vascular system; stems with wood and true bark; wood arranged in concentric circles, augmented by growth from without, the hardest parts being internal; bark separable; epidermis furnished with stomata; leaves reticulated, usually articulated to stem; type of fructification quinary or quatenary; embryo dicotyledonous; germination exorhizal.

I. *SUB-CLASS.*—BISEXUAL-EXOGENS (Monoclineæ).

Male and female organs of reproduction on the same flower.

I. ALLIANCE.—EPIGYNOUS-EXOGENS (Epigyneæ).

Flowers commonly hermaphrodite; stamens growing to the side of either the calyx or corolla; ovary inferior or nearly so.

I. ORDER.—ASARALS (Asarales).

Flowers monochlamydeous; embryo small, lying in a large quantity of albumen.

1. FAMILY.—*Birthworts* (Aristolochiaceæ). Herbs or shrubs, often climbing; wood without concentric zones; leaves alternate, simple, stalked; flowers solitary, axillary, of a dull colour; stamens 6–12; ovary 3–6-celled; ovules 00; fruit dry or succulent. Abound in warm parts of South America, rare in North America, Europe, Siberia and India; yield Asarabacca and Virginian Snake-root.
2. FAMILY. — *Mistletoes* (Loranthaceæ). Shrubs,

usually parasitic; leaves opposite or alternate, veinless, fleshy, exstipulate; flowers often showy, axillary or terminal; calyx often bracteated; petals 0; ovary unilocular; ovules definite, nucleus naked; fruit succulent. Common in equinoctial Asia, and America, rare in Africa, Europe, at the Cape of Good Hope, and in Australia. The celebrated mistletoe of the Druids (*Viscum album*) belongs to this family.

3. FAMILY.—*Sandal-Woods* (Santalaceæ). Trees, shrubs, or herbs; leaves exstipulate; flowers mostly in spikes; perianth 4–5-cleft; ovary coherent, 1-celled; ovules definite,[1] nucleus coated; fruit 1-celled, drupaceous; seed solitary. Occur as shrubs in Europe, and North America, and as shrubs or small trees in the East Indies, Australia, and Polynesia. Yield Sandal-wood, Oil-nuts, &c.

II. ORDER.—UMBELLAIS (Umbellales).

Flowers polypetalous, dichlamydeous; seeds large, solitary; embryo small, in a large quantity of albumen.

1. FAMILY. — *Bruniads* (Bruniaceæ). Shrubs, branched, heath-like; leaves alternate, small, imbricated, entire, exstipulate; flowers small, often capitate; petals alternate with segments of calyx; stamens alternate with petals; anthers turned outwards, 2-celled, dehiscence longitudinal; fruit 2 or 1-celled,

dicoccous or indehiscent. Natives of the Cape of Good Hope.

2. FAMILY. — *Witch - Hazels* (Hamamelidaceæ). Shrubs or small trees; leaves alternate, feather-veined, stipulate; flowers small, sometimes unisexual; corolla imbricated; anthers turned inwards, 2-celled, with deciduous valves; fruit capsular, 2-celled, dehiscence loculicidal; seeds pendulous. Occur in North America, Japan, China, Central Asia, Madagascar, and Southern Africa.

3. FAMILY.—*Dogwoods* (Cornaceæ). Trees, shrubs, or herbs; leaves mostly opposite, exstipulate; flowers capitate, umbellate, or corymbose; corolla valvate; sepals, petals, and stamens four; anthers 2-celled; fruit drupaceous, berried, 2-celled, crowned by limb of calyx; seed pendulous, solitary. Found in temperate parts of Europe, Asia, and America.

4. FAMILY.—*Ivy-Worts* (Araliaceæ). Trees, shrubs, or herbs; leaves alternate, exstipulate; flowers umbellate or capitate, pentamerous; corolla valvate; anthers turned inwards, dehiscence longitudinal; ovary inferior, 2 or more celled; fruit mostly succulent, 2–15-celled; seeds pendulous. Occur both in tropical and in cold climes. Among its members are the common Ivy and other species of *Hedera*. The Ginseng root of the Chinese is yielded by a species of *Panax*.

5. FAMILY.—*Umbellifers* (Apiaceæ). Herbs, often

milky; stems solid or fistular; leaves mostly alternate, variously divided; flowers umbellate, involucrate, white, pink, yellow, or blue; calyx superior, 5-toothed; petals and stamens five; ovary inferior, 2-celled; ovules pendulous, crowned by a double fleshy disk; fruit a cremocarp, consisting of two carpels adherent by their face to a common axis; seed pendulous, usually firmly adherent to pericarp. From its vast extent, amounting to 267 genera, and about 1500 species, it has been subdivided as follows:—

1. SUB-FAMILY.—*Orthospermæ.* Albumen flat on the inner face, neither involute, nor convolute.
2. SUB-FAMILY.—*Campylospermæ.* Albumen curved at the margins.
3. SUB-FAMILY.—*Cœlospermæ.* Albumen curved at the ends.

The species are also arranged according to their properties into 1, harmless; 2, those affording a gum-resin; 3, those yielding a volatile oil; and 4, the poisonous. Among the first are the Carrot (*Daucus*), Parsnip (*Pastinaca*), Celery (*Apium*), Parsley (*Petroselinum*), Fennel (*Fœniculum*), Angelica (*Archangelica*), Samphire (*Crithmum*), and Earth-Nut (*Bunium*). The second divison affords many medicinal agents, as the Assafœtida (*Narthex*), Ammoniac (*Dorema*), Opoponax (*Pastinaca*), Galbanum (*Opoidia*), and Sagapenum, derived from a species of *Ferula.* The third also yields numerous important substances, as Anise (*Pimpinella*), Caraway (*Carum*), Coriander (*Coriandrum*), Cumin (*Cuminum*), and Dill (*Anethum*). Among the dangerous individuals of the last division may be noted Hemlock (*Conium*), Water-Hemlock (*Cicuta*), Fool's-Parsley (*Æthusa*), and the species of *Œnanthe.* The distribution of this family, which is the *Umbelliferæ* of authors, is widely extended.

III. ORDER.—CINCHONALS (Cinchonales).

Flowers dichlamydeous, monopetalous; embryo minute, in a large quantity of albumen.

1. FAMILY.—*Madders* (Rubiaceæ). Herbs, stems square; leaves whorled, exstipulate; flowers minute; corolla 4–6-lobed; stamens epipetalous; anthers bursting longitudinally; fruit didymous; cotyledons leafy. Natives of the Northern Hemisphere, also of mountainous parts of Peru, Chili, and Australasia. Madder is the product of the root of several species of *Rubia.* (*Galiaceæ.* Lindley.)
2. FAMILY.—*Honeysuckles* (Caprifoliaceæ). Shrubs or herbs; leaves opposite, exstipulate; flowers corymbose, often sweet scented; calyx 4–5-cleft; corolla lobed; stamens epicorolline; anthers bursting longitudinally; fruit fleshy or dry, indehiscent. Contains two Sub-families, viz., 1, the *Lonicereæ* or Honeysuckles proper, with a raphè on inner side of ovule, and 2, the *Sambuceæ* or Elders, with a raphè on outer side of ovule. Occur principally in

Northern parts of Europe, Asia, and America, also sparingly in Northern Africa. Contains Honeysuckle, Elder, Gueldres-Rose, and the beautiful *Linnæa borealis.*

3. FAMILY.—*Peruvian-Barks* (Cinchonaceæ). Trees, shrubs, or herbs; stems rounded; leaves simple, opposite or verticillate, with interpetiolar stipules; flowers usually in panicles or corymbs; calyx adherent; corolla tubular, lobed; stamens epipetalous; anthers straight, bursting longitudinally; ovary crowned with a disk; fruit 2 or many celled, dry or succulent, indehiscent, or splitting into two mericarps; cotyledons thin. A most important family, yielding the various "Barks" of commerce and their products Quina, and Cinchonia, also Ipecacuan, Coffee, a variety of Catechu, &c. Divided into two Subfamilies, which are, 1, the *Coffeæ,* with one or two seeds in each cell of the ovary, and 2, the *Cinchoneæ* with a many-seeded ovary. Live almost entirely in tropical regions.

4. FAMILY.—*Columelliads* (Columelliaceæ). Evergreen shrubs, or trees; leaves opposite, exstipulate; flowers unsymmetrical, yellow, terminal; calyx 5-parted; corolla rotate, 5–8-parted; stamens two, epipetalous; anthers sinuous, bursting longitudinally; fruit capsular, bilocular; cotyledons oval, obtuse. Natives of Mexico and Peru.

5. FAMILY.—*Cranberries* (Vacciniaceæ). Shrubby

plants, frequently evergreen, occasionally epiphytic; leaves alternate, undivided, exstipulate; flowers solitary or racemose; calyx and corolla usually 4–6-lobed; stamens 8–12, distinct; anthers opening by pores; fruit succulent; cotyledons very short. Found in temperate regions, often in marshy places. Yield Bilberries, Cranberries, Whortleberries, &c.

IV. ORDER.—GROSSALS (Grossales).

Flowers dichlamydeous, polypetalous; seeds numerous, minute; embryo small, in a large quantity of albumen.

1. FAMILY. — *Barringtoniads* (Barringtoniaceæ). Trees or shrubs; leaves opposite or verticillate, not dotted; sepals and petals 4–5; stamens 00, mostly monadelphous; anthers oblong; ovary 2–5-celled; placentæ axile; fruit fleshy, 1-celled. Tropical plants in both hemispheres, some found in low, moist situations.
2. FAMILY.—*Syringas* (Philadelphaceæ). Shrubs; leaves deciduous, opposite, exstipulate, without dots; flowers white or pink, in trichotomous cymes; calyx valvate; stamens 00; styles distinct, or united into one; placentæ axile; fruit capsular. Occur in Southern Europe, North America, India, and Japan.
3. FAMILY.—*Escalloniads* (Escalloniaceæ). Shrubs; evergreen; leaves alternate, simple, resin-

ously glandular, exstipulate; calyx imbricated; petals and stamens five; ovary 2–5-celled; style simple; placentæ axile; fruit capsular; albumen oily. Occur chiefly in temperate parts of South America, but reach as far as the Straights of Magellan; found also in Bourbon, South Australia, and New Zealand.

4. FAMILY.—*Currants* (Grossulariaceæ). Shrubs; unarmed or spiny; leaves alternate, lobed; vernation plicate; flowers in axillary racemes; calyx 4–5-cleft; petals five, perigynous; stamens 4–5; ovary unilocular; placentæ parietal; fruit a 1-celled berry, crowned with the remains of the flower. Live in temperate regions in Europe, Asia, and America; unknown in Africa. Yield various edible fruits, as the Gooseberry and the varieties of the Currant.

V. ORDER.—CACTAILS (Cactales).

Flowers dichlamydeous, polypetalous; placentæ parietal; embryo with little or no albumen.

1. FAMILY.—*Indian - Figs* (Cactaceæ). Shrubs; succulent; woody matter often arranged in wedges; stems mostly angular or flattened; leaves usually wanting, when present, fleshy, smooth, entire, or spinous; flowers sessile, showy or minute; sepals and petals numerous, undistinguishable; stamens 00; anthers

ovate, versatile; ovary fleshy, unilocular; styles confluent; ovules 00, horizontal; fruit succulent, 1-celled, smooth, scaly or tubercular; albumen none. Natives of dry, hot, and exposed situations; almost exclusively American, though numerous species have been introduced into the Eastern Hemisphere. Many produce an edible fruit, which is often refreshing, as the Barbadoes-Gooseberry, and the Prickly-Pear. The principal food of the Cochineal-Insect is obtained from plants of this family, but especially from the *Opuntia cochinellifera*.

2. FAMILY.—*Chili-Nettles* (Loasaceæ). Herbaceous; hispid, with stinging hairs; leaves opposite or alternate, exstipulate; peduncles axillary, 1-flowered; calyx 4–5-parted; petals five; stamens 00, distinct or polyadelphous; ovules confluent, pendulous; fruit capsular or succulent. American plants. Occurring in temperate and tropical regions; distinguished on account of their stinging properties.

3. FAMILY.—*Homaliads* (Homaliaceæ). Trees or shrubs; leaves alternate; stipules deciduous; flowers in spikes, racemes, or panicles; calyx funnel-shaped, 5–15-divided; petals 5–15; stamens opposite petals; styles 3–5, separate; ovules pendulous; fruit baccate or capsular. Tropical plants, chiefly African, or Indian; a few are found in the West Indies and South America.

VI. ORDER.—Myrtals (Myrtales).

Flowers dichlamydeous, polypetalous; placentæ axile; embryo with little or no albumen.

1. Family.—*Brazil-Nuts* (Lecythidaceæ). Large trees; leaves alternate, not dotted; flowers showy, terminal, solitary, or racemose; calyx valvate or imbricate; petals 6; stamens monadelphous; anthers oblong; ovary plurilocular; fruit a woody capsule, either remaining closed or opening by a lid. Found in Guiana and other hot parts of South America. Yield Brazil-Nuts.
2. Family.—*Myrtle-blooms* (Myrtaceæ). Trees or shrubs; leaves opposite or alternate, entire, usually dotted, and often with an intrumarginal line; inflorescence variable; flowers red, white or yellow, never blue; calyx valvate, 4–5-cleft; petals 4–5; stamens usually 00; anthers oblong, 2-celled; ovary plurilocular; fruit dry or fleshy. Natives of hot countries, both intratropical and extratropical. Among the members of this family are the huge *Eucalypti* of New Holland, one of which produces "Botany-Bay Kino," the Guava-tree, and the Pomegranate, and among the products are Cloves, Pimento, and Cajeput-Oil.
3. Family.—*Melastomads* (Melastomaceæ). Trees, shrubs, or herbs; leaves opposite, undivided, usually 3–9-ribbed, dotless; flowers terminal; calyx imbricated, 4–6-lobed; petals 4-6; sta-

mens definite; anthers rostrate; ovary plurilocular; fruit dry or succulent; seeds very numerous. Chiefly tropical plants, some occur in North India, China, Australia, and the United States. The succulent fruit of some species is edible; that of *Melastoma* dyes the mouth black, whence the name.

4. FAMILY.—*Napoleon-Worts* (Belvisiaceæ). Shrubs; wood soft, whitish; leaves alternate, coriaceous, exstipulate; flowers axillary, in sets of threes; calyx gamosepalous; corolla in three monopetalous rings; stamens indefinite, monadelphous; ovary plurilocular; fruit a large, soft, spherical berry; seeds large, kidney-shaped. The two curious genera which, at present, compose this family are from tropical Africa.

5. FAMILY.—*Mangroves* (Rhizophoraceæ). Trees or shrubs; leaves opposite, simple, occasionally dotted; stipules deciduous, interpetiolary; peduncles axillary or terminal; calyx valvate, 4-12-lobed; petals 4-12; stamens indefinite; ovary 2, 3, 4-celled; fruit indehiscent, adherent to, and crowned by the calyx; seed pendulous; cotyledon flat; radicle long, piercing the fruit. Occur on muddy shores in the tropics, where they form close thickets.

6. FAMILY. — *Evening - Primroses* (Onagraceæ). Herbs or shrubs; leaves alternate or opposite, simple, not dotted; flowers axillary or terminal, variously coloured; calyx valvate,

tubular; petals usually four; stamens mostly four or eight; ovary 2–4-celled; ovules horizontal or ascending; fruit baccate or capsular; cotyledons flat, larger than the radicle. Natives of temperate regions, chiefly American. Some as various species of *Fuchsia*, yielding edible fruit, others, as the Water-Chesnut (*Trapa natans*), edible seeds.

7. FAMILY.—*Mares'-Tails* (Haloragaceæ). Herbs or under-shrubs, often aquatic; leaves alternate, opposite, or whorled; flowers axillary, mostly sessile, occasionally apetalous; calyx open, minute; stamens definite; ovary plurilocular, adherent to calyx; ovules pendulous; fruit dry, indehiscent; cotyledons minute. Distribution pretty general in damp places.

8. FAMILY.—*Fringe-Myrtles* (Chamælauciaceæ). Shrubs, heath-like; abound in glandular oily cysts; leaves evergreen, acerose, flat, opposite, dotted; flowers racemose or corymbose, yellow, red, violet or white; calyx adherent to ovary; ovary 1-celled; fruit a dry indehiscent pericarp; embryo homogeneous. Natives of New Holland.

9. FAMILY.—*Alangiads* (Alangiaceæ). Trees or shrubs; branches often spiny; leaves alternate, exstipulate, dotless; flowers fascicled, axillary; calyx campanulate; petals 5–10; anthers introrse; ovary globose, 1–2-celled; ovules pendulous; fruit oval, fleshy; cotyle-

dons flat. Natives of Southern India; one genus (*Nyssa*) occurs in the United States.

10. FAMILY.—*Myrobalans* (Combretaceæ). Trees or shrubs; leaves alternate or opposite, entire, dotless; calyx adherent; anthers bursting longitudinally; ovary 1-celled; fruit drupaceous, baccate or nut-like; seeds pendulous; cotyledons convolute or plicate. Natives of tropical Asia, Africa, and America

11. FAMILY.—*Illigerads* (Illigeraceæ). Trees or shrubs; leaves opposite or alternate, exstipulate; calyx adherent; corolla wanting; anthers debiscing by recurved valves; ovary 1-celled; fruit unilocular, indehiscent; cotyledons convolute. Occur in inter-tropical regions.

VII. ORDER.—CAMPANALS (Campanales).

Flowers dichlamydeous, monopetalous; embryo with little or no albumen.

1. FAMILY.—*Composites* (Asteraceæ). Herbaceous, shrubby, or occasionally arborescent; leaves alternate or opposite, exstipulate, simple, but often much divided; flowers, named "florets," unisexual or hermaphrodite, collected in dense heads upon a common receptacle, and surrounded by bracts in the form of an involucre; corolla gamopetalous, ligulate, tubular, or bilabiate, æstivation valvate; anthers syngenesious; ovary 1-celled; ovule erect;

fruit an achænium; seed solitary, erect, exalbuminous. One of the largest of the natural families of plants; divided by De Candolle into 1 *Tubulifloræ*, 2 *Labiatifloræ*, and 3 *Liguliforæ;* arrayed by Jussieu into the following Sub-families, viz.:—

1. *Cynarocephalæ.* Florets all tubular; involucre hard, conical, often spiny,
2. *Corymbiferæ.* Florets tubular in the centre, ligulate in the circumference; involucre hemispherical, leafy or scaly, seldom spiny.
3. *Cichoraceæ.* Florets all ligulate.

To which has been subsequently added,—

4. *Bilabiatæ.* Florets divided into two lips.

Of these, the first two correspond to the *Tubulifloræ*, the third to the *Liguliforæ*, and the fourth to the *Labiatifloræ.* The distribution of composite plants is very general, but does not follow any very fixed law; in northern climates they are shrubs, but in warmer regions they are herbaceous, or even arborescent. *Cichoraceæ* are more abundant in cold climes, while *Corymbiferæ* prefer warm countries; the *Bilabiatæ* are mostly American. Among the plants, &c., employed by man from this family are Wormwood (*Artemisia Absinthium*), Southernwood (*A. Abrotanum*), Moxa (*A. Moxa*), Tansy (*Tanacetum vulgare*), Milfoil (*Achillea millefolia*), Chamomile (*Anthemis nobilis*), Feverfew (*Pyrethrum parthenium*), Pellitory of Spain (*Anacyclus Pyrethrum*), Leopard's-Bane (*Arnica montana*), Elecampane (*Inula Helenium*), Jerusalem-Artichoke

(*Helianthus tuberosus*), Burdock (*Arctium Lappa*), Blessed-Thistle (*Cnicus benedictus*), Safflower (*Carthamus tinctorius*), Artichoke (*Cynara Scolymus*), Chicory (*Cichorium Intybus*), Endive (*C. Endivia*), Dandelion (*Taraxacum Dens-leonis*), Common-Lettuce (*Lactuca sativa*), Wild-Lettuce (*L. virosa*) Scorzonera (*Scorzonera Hispanica*).—(*Compositæ*, De Candolle.)

2. FAMILY.—*Calycers* (Calyceraceæ). Herbs; leaves alternate, exstipulate; flowers sessile, capitate, surrounded by an involucre; corolla regular, valvate, infundibuliform; anthers syngenesious; ovary 1-celled; ovule pendulous; fruit an achænium; seeds albuminous. Natives of South America, especially Chili.

3. FAMILY.—*Teazels* (Dipsacaceæ). Herbs or undershrubs; leaves opposite or verticillate; flowers capitate or verticillate, surrounded by a many-leaved involucre; corolla gamopetalous, tubular; æstivation imbricate; anthers free; ovary 1-celled; ovule pendulous; fruit dry, indehiscent; seeds albuminous. Occur in the South of Europe, the Levant, Barbary, and at the Cape of Good Hope.

4. FAMILY.—*Valerians* (Valerianaceæ). Herbs, annual or perennial, usually strong-scented; leaves opposite, exstipulate; inflorescence cymose; corolla imbricate; anthers free; ovary 1-celled; ovule pendulous; fruit dry, indehiscent, with one fertile, and two abortive cells; seed exalbuminous. Natives of tem-

perate regions. The root of the Common-Valerian (*Valeriana officinalis*) is employed medicinally.

5. FAMILY.—*Style-Worts* (Stylidiaceæ) Herbs or under-shrubs, non-lactescent; leaves alternate, scattered, or somewhat verticillate, exstipulate; flowers in spikes, racemes or corymbs, or solitary and terminal, rarely axillary; corolla gamopetalous; æstivation imbricate; stamens two; filaments and style united into a column, which is very irritable; anthers didymous; ovary 2 or more celled; fruit a capsule, with 2 valves and 2 cells; seeds albuminous. Principally inhabit Australian marshes, but occur also in India, the South of New Zealand, and along the Straits of Magellan.

6. FAMILY.—*Goodeniads* (Goodeniaceæ). Herbs, rarely shrubs, non-lactescent; leaves scattered, exstipulate, usually alternate; flowers distinct, never capitate, yellow, blue, or pink; corolla induplicate; stamens five; anthers syngenesious or free; stigma surrounded by a cup-like indusium; ovary 2 or more celled; fruit capsular, drupaceous or nut-like; seeds albuminous. Natives of Australasia and Polynesia.

7. FAMILY.—*Lobelias* (Lobeliaceæ). Herbs or shrubs, lactescent; leaves alternate, exstipulate; flowers axillary or terminal; corolla gamopetalous; æstivation valvate, irregular;

anthers syngenesious; stigma surrounded by a fringe of hairs; ovary 1–3-celled; fruit capsular, dehiscing at the apex; seeds numerous, albuminous. Found in the West Indies, Brazil, Chili, on the Himmalayas, at the Cape of Good Hope, in the Sandwich-Islands, and Australia. Some species of *Lobelia* are medicinal. The plants are generally acrid.

8. FAMILY.—*Bell-Flowers* (Campanulaceæ). Herbs or under-shrubs, lactescent; leaves mostly alternate, exstipulate; flowers in racemes, spikes, or panicles, or in heads, usually blue or white; corolla monopetalous; æstivation valvate; anthers free or half united; stigma naked; ovary 2 or more celled; fruit capsular; seeds albuminous. Occur in the North of Europe, Asia, and America, also in the Canaries, St. Helena, at the Cape of Good Hope, and in Juan Fernandez.

II. ALLIANCE.—PERIGYNOUS-EXOGENS (Perigyneæ).

Flowers commonly hermaphrodite; stamens growing to the side of either the calyx or corolla; ovary superior, or nearly so.

I. ORDER.—BIGNONIALS (Bignoniales).

Flowers dichlamydeous, monopetalous, unsymmetrical; fruit capsular or berried, carpels consolidated; placentæ parietal, free, central, or axile; embryo with little or no albumen.

1. Family.—*Butter-Worts* (Lentibulariaceæ). Herbs, aquatic or marshy; leaves radical, sometimes compound, bearing little vesicles; flowers single, in spikes, or in many-flowered racemes; corolla bilabiate; stamens two; ovary composed of two carpellary leaves; fruit capsular, dehiscence transverse or apicilar; placentæ free, central; seeds minute, exalbuminous; cotyledons much smaller than the radicle. Distribution very general, especially abundant within the tropics.

2. Family.—*Fig-Worts* (Scrophulariaceæ). Herbs, under-shrubs, or shrubs; leaves opposite, whorled, or alternate; flowers mostly axillary or racemose; corolla bilabiate or personate; æstivation imbricate; stamens usually four; ovary free, 2-celled; placentæ axile; fruit capsular, rarely fleshy; seeds albuminous; cotyledons scarcely larger, or not so large as the radicle. Found in most parts of the world, one species occurs in Melville Island, and several in Tierra del Fuego. Several members of this family have been used in medicine, as Great-Mullein (*Verbascum Thapsus*), Knotted-Figwort (*Scrophularia nodosa*), and especially Foxglove (*Digitalis purpurea*).

3. Family.—*Acanths* (Acanthaceæ). Herbs or shrubs; leaves opposite, exstipulate; inflorescence terminal or axillary; flowers bracteated; stamens 2–4; ovary free, 2-celled;

placentæ axile; fruit capsular, 2-celled, dehiscence loculicidal, by two elastic valves; seeds wingless, exalbuminous, attached to hard, persistent, placental processes; cotyledons large, fleshy. Almost entirely a tropical family; one species occurs in Greece, and a few in the United States.

4. FAMILY. — *Trumpet - Flowers* (Bignoniaceæ). Trees, shrubs, or herbs; leaves mostly opposite, exstipulate; inflorescence terminal; calyx sometimes spathaceous; corolla usually irregular; stamens five; ovary 1–2-celled; placentæ axile; fruit capsular, 2-celled, 2-valved; seeds winged, sessile, exalbuminous; cotyledons large, leafy. Abound in tropical countries, but occur in America, from Pennsylvania to Chili.

5. FAMILY.—*Crescentiads* (Crescentiaceæ). Small trees; leaves alternate or clustered, exstipulate; flowers growing out of the old stems or branches; corolla irregular; æstivation imbricate; stamens four; ovary free; stigma of two lobes; fruit woody, melon-shaped, succulent, containing numerous large seeds immersed in the pulp of the placentæ; embryo exalbuminous; radicle short. Natives of tropical Asia, Africa, and America, especially abundant in Madagascar and the Mauritius.

6. FAMILY.—*Gesner-Worts* (Gesneraceæ). Herbs or shrubs, soft wooded, often springing from scaly tubers; leaves opposite or whorled,

rugose, exstipulate; flowers showy, in racemes or panicles; corolla tubular, irregular; æstivation imbricate; stamens 2–4; ovary partly free; placentæ parietal; fruit capsular or baccate, 1-celled; seeds very numerous; cotyledons minute, radicle long. Occur in tropical countries, but also in Europe, at the Cape of Good Hope, in New Holland, and the Sandwich Islands.

7. FAMILY.—*Pedaliads* (Pedaliaceæ). Herbs, covered with glandular hairs; leaves opposite or alternate, exstipulate; flowers usually large, axillary, solitary or clustered; corolla irregular, æstivation valvate; stamens didynamous; ovary 1-celled; placentæ parietal; fruit drupaceous or capsular; seeds wingless, exalbuminous; embryo amygdaloid; radicle short. Distribution general throughout the tropics, but especially in Africa.

II. ORDER.—ECHIALS (Echiales).

Flowers dichlamydeous, monopetalous, symmetrical or non-symmetrical; fruit nucamentaceous, consisting of 1-seeded nuts, or of clusters of them separate or separable; embryo large, with little or no albumen.

I. *SUB-ORDER.*—UNSYMMETRICAL-ECHIALS (Lamianæ).

Flowers irregular, unsymmetrical.

1. FAMILY.—*Selagids* (Selaginaceæ). Herbs or small branched shrubs; leaves alternate,

exstipulate; flowers sessile, bracteate; calyx spathaceous or tubular; æstivation imbricate; stamens four; anthers 1-celled; ovules pendulous; fruit confluent nuts, 2-celled; seed solitary, pendulous; radicle superior. Principally natives of the Cape of Good Hope; one species is found in Siberia, and a few occur in the South of Europe.

2. Family. — *White-Mangroves* (Myoporaceæ). Shrubs, scarcely pubescent; leaves alternate or opposite, exstipulate, simple; flowers axillary; stamens four; anthers 2-celled; ovary 2–4-celled; ovules pendulous; fruit drupaceous; seeds pendulous; radicle superior. Occur in the Southern tropical regions of Africa and America, also in Australia, Van Diemen's Land, and New Zealand.

5. Family.—*Vervains* (Verbenaceæ). Trees, shrubs, or herbs; leaves mostly opposite, exstipulate; flowers usually in opposite corymbs, or alternate spikes; calyx and corolla tubular; æstivation imbricate; stamens four; ovary 2–4-celled; ovules erect; fruit nucamentaceous, sometimes berried; radicle inferior. Common in tropical and temperate America. Occur also in Europe, and Asia. The most important species is the East Indian Teak (*Tectona grandis*).

4. Family.—*Mints* (Lamiaceæ). Herbs or undershrubs; stem tetragonal; leaves opposite, exstipulate, with receptacles of aromatic oil;

inflorescence cymose, flowers often in verticillasters; corolla bilabiate, the upper lip entire or bifid, lower layer, 3-lobed; stamens four; ovary free, deeply 4-lobed; ovules four; stigma bifid; fruit 1 to 4 small achænia, enclosed within the persistent calyx; seeds erect; cotyledons flat; radicle inferior. Natives chiefly of temperate countries. Among the more important species, are Peppermint (*Mentha piperita*), Spearmint (*M. viridis*), Pennyroyal (*M. Pulegium*), Lavender (*Lavandula vera*), Rosemary (*Rosmarinus officinalis*), Wild-Marjoram (*Origanum vulgare*), Sweet-Marjoram (*Melissa officinalis*), White-Horehound (*Marrubium vulgare*), Sage (*Salvia officinalis, S. grandiflora*), Thyme (*Thymus*), and Kretan-Dittany (*Origanum Dictammus*). (*Labiatæ*, Jussieu.)

II. *SUB-ORDER.*—SYMMETRICAL-ECHIALS (Boraginanæ).

Flowers regular, symmetrical.

5. FAMILY.—*Brunoniads* (Brunoniaceæ). Herbs, stemless, with simple glandless hairs; leaves radical, exstipulate; flowers capitate, on scapes, surrounded by an involucre of enlarged bracts, blue; calyx free; corolla almost regular; æstivation valvate; stamens five; stigma enclosed in an indusium; fruit a membranous utricle; seed solitary, erect, exalbuminous; radicle inferior. Australian species.

6. Family.—*Borages* (Boraginaceæ). Herbs or shrubs; stems round; leaves alternate, rough, exstipulate; flowers usually in gyrate cymes; æstivation imbricate; stamens five; ovary usually 4-lobed; ovules four; stigma naked, simple or bifid; fruit 2 or 4 distinct nuts; radicle superior. Natives of northern temperate regions. Alkanet, the root of *Anchusa tinctoria*, is used by dyers.

7. Family.—*Nolanads* (Nolanaceæ). Herbaceous or suffruticose, prostrate or erect; leaves alternate, exstipulate; inflorescence straight; flowers usually showy; calyx 5-parted, æstivation valvate; corolla with æstivation plicate; stamens five; stigma naked, somewhat capitate; fruit five or more nuts, distinct or partly confluent; pericarp woody, often a little succulent; embryo curved. A small family, almost entirely Chilian.

8. Family.—*Ehretiads* (Ehretiaceæ). Trees, shrubs, or herbs; pubescence harsh; leaves alternate, exstipulate; flowers gyrate; æstivation imbricated; stamens five; ovary quadrilocular, concrete; style terminal; fruit drupaceous; seeds usually albuminous. Occur principally in South America.

9. Family.—*Heliotropes* (Heliotropiaceæ). Trees, shrubs, or herbs; leaves alternate, simple, exstipulate; inflorescence circinnate; stamens five; stigma naked; style terminal; ovary entire or 2-lobed; fruit dry, separable into

four achænia; seeds exalbuminous. Found in the South of Europe, and in tropical regions.

10. FAMILY. — *Sacred-Mustards* (Salvadoraceæ). Small trees or shrubs; stem slightly tumid at the articulations; leaves opposite, leathery; flowers minute, in loose panicles; calyx 4-leaved; corolla 4-parted; stamens four; ovary 1-celled; stigma naked, sessile; fruit solitary, succulent; embryo exalbuminous. Contains but one genus, viz., *Salvadora*, to which the Mustard-Tree of Scripture has been referred by Royle. The species occur in Syria, India, and North Africa.

11. FAMILY.—*Jessamines* (Jasminaceæ). Shrubs; stems often climbing; leaves opposite or alternate, compound; flowers opposite, corymbose, white or yellow; æstivation twisted or valvate; stamens two; ovary free, 2-celled; stigma naked, 2-lobed; fruit a double berry, a pyxidium, or a 2-valved capsule; seeds with little or no albumen; radicle inferior. Chiefly inhabit Tropical India, but occur also in Southern Europe, Africa, South America, and Australia.

III. ORDER—CORTUSALS (Cortusales).

Flowers monodichlamydeous; placentæ free, central; embryo with much albumen.

1. FAMILY.—*Malaspinæads* (Ægicerataceæ). Shrubs; leaves alternate, undivided; flowers small,

monopetalous; stamens opposite petals; anther-cells cut transversely; ovary 1-celled; stalk of placentæ much lengthened during ripening, being converted into a false funiculus; fruit fleshy, follicular when ripe; seeds exalbuminous. Composed of a single genus inhabiting tropical shores.

2. FAMILY. — *Ardisiads* (Myrsinaceæ). Trees, shrubs, or under-shrubs; stem woody; leaves alternate or opposite, coriaceous, smooth, exstipulate; inflorescence in umbels, corymbs, or panicles, mostly axillary; flowers small, white or red, occasionally unisexual; calyx and corolla 4–5-cleft; stamens opposite petals; anthers sagittate; ovary free or partially adherent; fruit drupaceous, indehiscent; seeds angular or roundish. Found in Asia, Africa, and America, in Bourbon, the Isle of France, Madagascar, the Azores, Canaries, and Madeira, and in New Zealand.

3. FAMILY.—*Primroses* (Primulaceæ). Herbaceous, or under-shrubs, annual or perennial; leaves usually radical, opposite, exstipulate; flowers on simple or umbellate scapes; calyx and corolla 5- rarely 4-cleft; stamens opposite segments; ovary 1-celled; style one; fruit capsular, valvate, many-seeded; seeds numerous, peltate. Occur principally in the Northern Hemisphere, in temperate and cold regions; in the tropics they inhabit sea-shores or lofty situations. Some occur in Australia.

Yield numerous horticultural favourites, as the Auricula, Primrose, Cowslip, Oxlip, &c.

4. **Family.**—*Rib-Worts* (Plantaginaceæ). Herbs, often stemless; leaves radical, ribbed; flowers hermaphrodite and spiked, or unisexual and solitary; corolla with a 4-parted limb; stamens alternate with segments; ovary sessile; style one; stigma hispid; fruit capsular, operculate; seeds sessile, peltate or erect. Distribution very general, but more abundant in temperate regions.

5. **Family.**—*Sea-Pinks* (Plumbaginaceæ). Herbs or under-shrubs; leaves alternate or fasciculate, exstipulate, somewhat sheathing at the base; calyx tubular; corolla monopetalous or pentapetalous; stamens opposite petals; ovary free, 1-celled; styles five, seldom four or three, each bearing a subulate stigma; fruit membranous, 1-seeded; seed inverted. Inhabit salt-marshes, and the sea-shores along the Mediterranean, Southern Russia, also in Affghanistan, Cabul, China, Australasia, the Cape of Good Hope, Cape Horn, and in Greenland.

6. **Family.**—*Water-leaves* (Hydrophyllaceæ). Trees, shrubs, or herbs, often hispid; leaves opposite or alternate, exstipulate, often lobed; flowers in gyrate racemes or unilateral spikes, occasionally solitary and axillary; calyx deeply 5-cleft; corolla shortly 5-cleft; æstivation plicate or imbricate; stamens alternate with

petals; ovary 1–2-celled; styles two, long; fruit capsular, 2-valved, 1–2-celled; placentæ parietal or central; seeds reticulated. Chiefly found in the Northern and Southern provinces of America, but occur sparingly also in the East Indies and the Cape of Good Hope.

IV. ORDER.—SOLANALS (Solanales).

Flowers dichlamydeous, monopetalous, symmetrical; placentæ axile; fruit 2–3-celled; embryo large, lying in a small quantity of albumen.

1. FAMILY.—*Phloxes* (Polemoniaceæ). Herbs, often climbing; leaves opposite or alternate, simple or compound; calyx 5-parted; corolla 5-lobed; stamens five, free; pollen often blue; ovary superior, 3-celled; style simple; stigma trifid; fruit capsular, 3-celled, 3-valved; seeds angular, oval or winged; cotyledons elliptical or cordate, foliaceous. Natives of temperate latitudes, chiefly in North and South America.
2. FAMILY.—*Dodders* (Cuscutaceæ). Parasitic, leafless, climbing, colourless; flowers in dense clusters; calyx 4–5-parted; corolla 4–5-cleft; æstivation imbricate; scales on coralline tube; stamens five, free; ovary 2-celled; stigmas two; placentæ basal; fruit capsular or baccate, 2-celled; cells 1–2-seeded; embryo spiral, filiform; cotyledons inconspicuous. Found in the temperate parts of both hemispheres.
3. FAMILY.—*Bindweeds* (Convolvulaceæ). Herbs or

shrubs, usually twining and milky; leaves alternate, undivided or lobed, exstipulate; inflorescence axillary or terminal; calyx persistent, in five divisions, imbricated; corolla deciduous, limb 5-lobed; æstivation plaited or imbricated; stamens five, alternate with segments of corolla; ovary simple, 2–4-celled; style one; placentæ basal; fruit 1–4-celled, succulent or capsular; cotyledons leafy, doubled up. Abundant in tropical, but rare in cold climes. Roots generally afford an acrid juice; yield Jalap, Scammony, Sweet Potato, Oil of Rhodium, &c.

4. FAMILY.—*Sebestens* (Cordiaceæ). Trees; leaves alternate, rough, exstipulate; flowers panicled, bracteate; calyx 4–5-toothed; corolla 4–5-cleft, imbricated; stamens five, free; ovary 4–8-celled; stigma 4–8-cleft; fruit drupaceous, 4–8-celled; seeds exalbuminous; cotyledons leafy, plaited longitudinally. Mostly tropical species in both worlds.

5. FAMILY.—*Milk-Weeds* (Asclepiadaceæ). Shrubs, occasionally herbs, usually milky, often twining; leaves mostly opposite, with interpetiolary cilia in place of stipules; flowers umbelled, fascicled, or racemose; calyx 5-divided, persistent; corolla 5-lobed, deciduous; æstivation imbricate, rarely valvate; stamens five; anthers and stigma consolidated into a column; ovaries two; fruit, two follicles, one sometimes abortive; seeds numerous; coty-

ledons leafy. Natives chiefly of Southern Africa, but occur also in Tropical India, Australia, Equinoctial and North America, and in Sicily. Among the species, is the Cow Plant (*Gymnema lactiferum*), the juice of which is employed as drink in Ceylon, Some are supposed to yield a kind of Caoutchouc.

6. FAMILY. — *Deadly-Nightshades* (Atropaceæ). Herbs or shrubs; leaves alternate; calyx tubular, 5-divided, persistent; corolla tubular, 5-lobed; æstivation imbricate or plicate; stamens five, alternate with lobes of corolla; anthers bilobed, bursting longitudinally at the margin; ovary 2-celled; ovules usually ascending; style simple; stigma bilobed; fruit baccate or capsular; seeds reniform or compressed; embryo straight or curved. Distribution extended. Contain Tobacco, Thorn-apple, Henbane, Deadly-Nightshade, Mandrake, &c. Most members of this family are more or less poisonous.

7. FAMILY.—*Nightshades* (Solanaceæ). Herbs or shrubs; leaves alternate; calyx and corolla 5- rarely 4-partite; æstivation valvate; stamens equal to, and alternate with, lobes of corolla; anthers burst by longitudinal slits or pores; ovary generally 2-celled; style simple; stigma bilobed or clavate, often hollow; fruit capsular or baccate; embryo terete. Distribution general. Among the species are the Potato, Bitter-sweet, Tomato,

Capsicum, Brazilian-Quina, &c. This family contains several innocuous plants.

8. Family.—*Olives* (Oleaceæ). Trees or shrubs; leaves opposite, simple or compound; flowers in terminal or axillary racemes or panicles, sometimes unisexual; calyx persistent; corolla 4-cleft; æstivation somewhat valvate; stamens 2, rarely 4, free; ovary simple, 2-celled; stigma entire or bifid; fruit drupaceous, baccate, or capsular, sometimes winged; seeds with abundant albumen; cotyledons leafy. Mostly frequent temperate regions, but a few are tropical. In this family are found the Olive, yielding olive-oil, the Flowering-Ash, affording manna; also the Common-Ash, Common-Lilac, Privet, &c.

V. ORDER.—GENTIANALS (Gentianales).

Flowers dichlamydeous, monopetalous; placentæ axile or parietal; embryo minute, or with the cotyledons much smaller than the radicle, lying in abundant albumen.

1. Family.—*Gentians* (Gentianaceæ). Herbs, seldom shrubs; leaves mostly opposite, exstipulate, often 3-5-ribbed; flowers regular, terminal or axillary; calyx and corolla persistent; æstivation plaited or imbricate-twisted; ovary of two carpels; style one, continuous; stigmas 1 or 2; placentæ parietal; fruit capsular or baccate, 1-celled, many-seeded. Distribution widely extended. Yields Gentian, Chiretta, Centaury, Marsh-Trefoil, &c.

2. FAMILY.—*Broom-rapes* (Orobanchaceæ). Herbaceous, parasitic, leafless; stems covered with scales; calyx divided, persistent; corolla usually bilabiate, persistent; æstivation imbricated; stamens four, didynamous; disk fleshy; style one; stigma 2-lobed; placentæ parietal; fruit capsular, enclosed within the withered corolla, 1-celled, 2-valved. Inhabit Southern Europe, Barbary, Cape of Good Hope, Northern and Middle Asia, and North America.

3. FAMILY.—*Stilbids* (Stilbaceæ). Shrubs; leaves whorled, close, leathery, exstipulate; flowers in dense spikes at the end of the branches; calyx tubular; corolla valvate; stamens equal to, and alternate with, segments of corolla; ovary sessile, 2-celled; style terminal, exserted; stigma simple; placentæ axile; fruit dry, 1-seeded; seeds definite, erect. A small family inhabiting the Cape of Good Hope.

4. FAMILY.—*Diapensiads* (Diapensiaceæ). Undershrubs, prostrate; leaves small, densely imbricated; flowers solitary, terminal; calyx of five sepals; corolla regular; æstivation imbricated; stamens five; filaments petaloid; anthers dehiscing transversely; ovary 3-celled; style simple, continuous; stigma sessile, with three short decurrent lobes; placentæ axile; fruit capsular; seeds indefinite, peltate. Mountain plants; found in the North of Europe and North America.

5. FAMILY.—*Cassipoureads* (Cassipoureaceæ). Trees

or shrubs; leaves opposite, stipulate; flowers axillary, solitary, or clustered; calyx campanulate, 4–5-cleft, valvate; petals 4–5, fringed; stamens distinct; ovary 3–5-celled; style simple; stigma obtuse; placentæ axile; fruit berried or capsular. A small tropical family.

6. Family.—*Poison-Nuts* (Loganiaceæ). Shrubs, herbs, or trees; leaves opposite, usually stipulate; flowers racemose, corymbose, or solitary; calyx 4–5-parted; corolla 4–5- or 10-divided; æstivation convolute or valvate; ovary usually 2-celled; style continuous; stigma simple; fruit capsular, drupaceous, or baccate; seeds peltate, sometimes winged. Found in tropical and sub-tropical regions. A poisonous series of plants, yielding False-Angostura Bark, St. Ignatius' Beans, Strychnia, Brucia, Ourari or Woorali poison, and Carolina-Pink.

7. Family.—*Dogbanes* (Apocynaceæ). Trees or shrubs, usually milky; leaves opposite, exstipulate; flowers large, showy; inflorescence corymbose; calyx 5-parted, persistent; corolla 5-lobed, deciduous; æstivation contorted; stamens five; ovaries two, unilocular, or one and bilocular; styles 2 or 1; stigma one, contracted in the middle; fruit follicular, capsular, drupaceous or baccate; seeds usually pendulous. Chiefly a tropical family, containing many poisonous species, among which are the tree affording Tanghin poison in Madagascar, Ole-

ander, Dogbane; also the Milk-tree of Demerara, which yields a fluid. Some supply a variety of Caoutchouc.

8. FAMILY.—*Hollies* (Aquifoliaceæ). Trees or shrubs, evergreen; leaves alternate or opposite, exstipulate; flowers small, white or greenish, axillary, solitary or clustered; calyx and corolla 4–6-parted, imbricated; stamens alternate with segments of corolla; disk none; ovary fleshy; stigma nearly sessile, lobed; placentæ axile; fruit fleshy, indehiscent, with 2–6-stones; seed pendulous. Found in North and South America, the West Indies, the Cape of Good Hope, one occurs in Europe. Yield Holly, Paraguay-tea, &c. (*Ilicineæ*, Brongniart.)

9. FAMILY. — *Ebonies* (Guaiacaraceæ). Trees or shrubs; wood heavy; leaves alternate, exstipulate, coriaceous; inflorescence axillary; flowers often unisexual; calyx 3–7-divided, persistent; corolla 3–7-divided, deciduous; æstivation imbricated; ovary free, sessile, plurilocular; style usually divided; stigma sessile, radiating; fruit fleshy, round or oval; seed suspended. Chiefly tropical. Occur in India, also in North and South America, Australia, Africa, and Europe. Yield Ebony, Ironwood, the Date-plum, &c. (*Ebenaceæ*, Vent.)

VI. ORDER.—RHAMNALS (Rhamnales).

Flowers monodichlamydeous; carpels consolidated; placentæ axile; fruit capsular, berried, or drupaceous; seeds definite; embryo amygdaloid; albumen little or none.

1. FAMILY.—*Storax-Worts* (Styracaceæ). Trees or shrubs; leaves alternate, exstipulate; flowers axillary, solitary or clustered, with scale-like bracts, monopetalous; calyx persistent; æstivation imbricated; stamens epipetalous; ovary 2–5-celled; ovules pendulous; style simple; stigma capitate; fruit drupaceous, enclosed in the calyx; radicle long; cotyledons foliaceous. Chiefly confined to tropical and sub-tropical countries. Among their products are Storax and Benzoin. (*Symplocineæ*, Don.)

2. FAMILY.—*Sappodillas* (Sapotaceæ). Trees or shrubs, often lactescent; leaves alternate, exstipulate; inflorescence axillary; flowers bisexual; calyx persistent, æstivation valvate or imbricate; corolla monopetalous, deciduous, æstivation imbricate; stamens epipetalous; ovary plurilocular; ovules ascending; style one; stigma sometimes lobed; fruit fleshy, mostly plurilocular; cotyledons albuminous or exalbuminous, radiate, short. Natives of tropical India, Africa, and America. Many yield edible fruits, as the Sappodilla-plum, Star-apple, Marmalade, Surinam-Medlar, &c.; Gutta Percha is afforded by *Isonandra Gutta.*

3. FAMILY.—*Stackhousiads* (Stackhousiaceæ). Herbs

or shrubs; leaves alternate, stipulate; flowers in spikes; calyx 5-cleft, with an inflated tube; petals five; stamens episepalous; ovary 3–5-celled; styles 3–5; stigmas simple; fruit of from 3 to 5 indehiscent pieces; cotyledons short, obtuse. A small Australian family.

4. FAMILY. — *Spindle-trees* (Celastraceæ). Small trees or shrubs; leaves mostly alternate, stipules small, deciduous; flowers in axillary cymes, small, white, green, or purple, occasionally unisexual; sepals and petals 4–5; imbricate; stamens alternate with petals; ovary 2–5-celled; fruit 2–5-celled, capsular or drupaceous; radicle short; cotyledons flat. Inhabit chiefly extratropical countries. Found in Europe, Asia, North and South America, at the Cape of Good Hope, and in New Holland.

5. FAMILY. — *Hippocrateads* (Hippocrateaceæ). Shrubs, arborescent or climbing, almost always smooth; leaves opposite, stipules small, deciduous; flowers in axillary racemes, small; sepals five, very small; petals five; æstivation imbricate; stamens three, monadelphous; style one; stigma 1-3; fruit of three samaroid carpels, or berried. Principally a South American family, but a few occur in Africa, the Mauritius, and the East Indies. Some yield edible fruits.

6. FAMILY.— *Chailletiads* (Chailletiaceæ). Trees

or shrubs; leaves alternate, stipulate; flowers small, axillary, fasciculate or corymbose; sepals and petals five; æstivation incurved, valvate; stamens five, alternate with petals; ovary 2–3-celled; styles 2–3; stigmas capitate or obscurely 2-lobed; fruit drupaceous, rather dry, 1, 2, 3-celled; seeds pendulous. A small family, occurring in Sierra Leone, Madagascar, Timor, and Equinoctial America.

7. FAMILY.—*Buckthorns* (Rhamnaceæ). Trees or shrubs, often spiny; leaves mostly alternate; stipules when present very minute; flowers small, generally green, axillary or terminal, rarely unisexual; calyx 4–5-cleft, valvate; petals distinct, hooded, or convolute; stamens opposite petals; ovary 2, 3, 4-celled; fruit fleshy and indehiscent, or dry and separating into three parts; seeds erect. Found in most parts of the world. Among the species are the Common-Buckthorn, Black-Alder, the Jujube-plant, the "Lotus" of the ancients, Christ's-thorn, New-Jersey Tea, &c.

8. FAMILY.—*Aloes-Woods* (Aquilariaceæ). Trees; leaves alternate or opposite, exstipulate; flowers apetalous; perianth coriaceous, imbricate, or tubular; stamens 5, 8, or 10; ovary 2-celled; ovules two, anatropal; stigma usually sessile; fruit capsular, sessile or stipulate, and 2-valved, or drupaceous and indehiscent; seeds two, pendulous. Natives of

Tropical Asia. The "Aloes" of Scripture is believed to be a species of *Aquilaria*.

9. **Family.**—*Sarcocols* (Penæaceæ). Shrubs, evergreen; leaves opposite, exstipulate; flowers usually red, apetalous; perianth salver-shaped; æstivation valvate or imbricate; stamens 4 or 8; ovary 4-celled; style simple; stigmas four; fruit capsular, 4-celled; cotyledons two, consolidated. Natives of the Cape of Good Hope.

VII. ORDER.—SAXIFRAGALS (Saxifragales).

Flowers monodichlamydeous; corolla, if present, polypetalous; carpels consolidated; placentæ sutural or axile; seeds 00; embryo small, taper; radicle long; albumen little or none.

1. **Family.**—*Loosestrifes* (Lythraceæ). Herbs or shrubs; leaves chiefly opposite, exstipulate, sometimes dotted; flowers solitary or clustered; calyx monosepalous, tubular, permanent, valvate; petals very deciduous, sometimes wanting; ovary 2–6-celled; placentæ axile or dissepimental; style filiform; stigma usually capitate; fruit capsular, dehiscent, membranous, surrounded by the calyx; seeds numerous. Found in Europe, India, North and South America. The Henné or Henna, used by women in Egypt, &c., for staining the fingers, is obtained from *Lawsonia inermis*.
2. **Family.**—*Brexiads* (Brexiaceæ). Trees; leaves

alternate, stipulate, not dotted; flowers green, in axillary umbels; calyx 5-parted, æstivation imbricate; petals five, æstivation twisted; stamens alternate with petals; ovary 5-celled; placentæ axile; stigma simple; fruit drupaceous, 5-celled; seeds with a double integument, exalbuminous (?). A Madagascar family.

3. FAMILY.—*Cunoniads* (Cunoniaceæ). Trees or shrubs; leaves opposite, stipules large, interpetiolar; calyx 4-5-cleft; petals 4 or 5, sometimes wanting; ovary 2-celled; styles two, distinct or combined; fruit 2-celled, capsular or indehiscent. Found at the Cape of Good Hope, in India, Australasia, and South America.

4. FAMILY.—*Hensloviads* (Hensloviaceæ). Trees; leaves opposite, exstipulate; flowers by abortion unisexual; perianth 5-parted, æstivation valvate; stamens five, alternate with segments; ovary 2-celled; stigma obsoletely 2-lobed; fruit capsular. Consists of a single genus, inhabiting tropical India.

5. FAMILY.—*Hydrangeads* (Hydrangeaceæ). Shrubs; leaves opposite, exstipulate; flowers in cymes, the marginal often sterile and dilated; calyx 4-6-toothed; petals 4-6, deciduous; stamens 8-12 in two rows, or 00; ovary of from 2 to 5 adherent carpels; styles 2-5, usually distinct; stigmas simple, reniform; fruit capsular, crowned by the permanent diverging

styles. Inhabit temperate parts of Asia and America; many in China and Japan.

6. **Family.**—*Saxifrages* (Saxifragaceæ). Herbs; leaves alternate, with or without stipules; calyx superior or inferior, of 4 or 5 sepals, cohering more or less at their base; petals 5 or 0, inserted between lobes of calyx; stamens 5-10; ovary usually of two carpels; placentæ sutural; styles none; stigmas sessile on the tips of the lobes of the ovary; fruit capsular, membranous, 1- or 2-celled, cells divaricating when ripe; seeds numerous. Natives of mountainous regions in northern countries.

VIII. ORDER.—Rosals (Rosales.)

Flowers monodichlamydeous; corolla, when present, polypetalous; carpels distinct; placentæ sutural; seeds definite; embryo amygdaloid; albumen little or none.

1. **Family.**—*Roses* (Rosaceæ). Herbs or shrubs; leaves alternate, stipulate, often dotted; flowers occasionally unisexual by abortion; calyx 4–5-lobed; petals 5 or 0; ovaries solitary or several, sometimes cohering into a plurilocular pistil; styles lateral; stigmas usually simple; fruit 1-seeded nuts, acini, or follicles; seeds usually suspended. Chiefly occur in temperate and cold parts of the Northern Hemisphere. No species is unwholesome; some yield edible fruits, as the

Strawberry, Raspberry, and Blackberry. Some Roses afford a valuable perfume, viz., "Attar of Roses;" "Kousso," from an Abyssinian plant named *Brayera anthelmintica*, is esteemed as the best remedy for Tapeworm.

2. FAMILY.—*Burnets* (Sanguisorbaceæ). Herbs or under-shrubs, occasionally spiny; leaves alternate, stipulate; flowers small, often capitate and unisexual, apetalous; perianth with a thickened tube; stamens definite; ovary solitary; stigma compound or simple; nut solitary, enclosed in the tube of the perianth, forming a false pericarp. Found in heaths and exposed places in Europe, North and South America, and at the Cape of Good Hope.

3. FAMILY.—*Apples* (Pyraceæ). Trees or shrubs; leaves alternate, stipulate; flowers solitary, or in terminal cymes; calyx adherent, 5-toothed; petals five, unguiculate; stamens indefinite; ovaries 1–5, fleshy; styles 1–5; stigmas simple; fruit a pome, mostly 1–5-celled. Occur in the Northern Hemisphere, in Europe, Northern Asia, North America; rare in Northern Africa and Madeira. Many afford edible fruits, as the Apple, Pear, Quince, Medlar, &c.; the seeds yield Hydrocyanic (Prussic) Acid. (*Pomaceæ*, Lindley.)

4. FAMILY.—*Almonds* (Amygdalaceæ). Trees or shrubs; leaves alternate, stipulate; flowers single or umbellate, white or pink; calyx 5-

toothed, deciduous; petals five; stamens twenty, arising from the throat of the calyx; ovary 1-celled; styles terminal, with a furrow on one side, ending in a reniform stigma; fruit drupaceous. Natives of cold and temperate parts of the Northern Hemisphere. Among the species are the Almond, Peach, Nectarine, Plum, Cherry, Laurel; the leaves and kernels yield Hydrocyanic Acid in abundance. (*Drupaceæ*, Lindley.)

5. FAMILY.—*Peas* (Fabaceæ). Herbs, shrubs, or trees; leaves alternate, usually compound; stipules two at base of petiole, and two at base of leaflet; flowers polypetalous or apetalous, frequently papilionaceous; calyx 5-partite, toothed or cleft; petals five or by abortion 4, 3, 2, 1, or none; stamens definite or indefinite; pistil simple, 1-celled, 1- or many-seeded; style simple, proceeding from the upper or ventral suture; stigma simple; fruit leguminous or drupaceous; cotyledons epigeal or hypogeal in germination. A very widely distributed, and most extensive family, comprising upwards of 6,500 species. It has been divided as follows:—

1. *Papilionaceæ.* Flowers papilionaceous; petals imbricated in æstivation, upper one exterior.
2. *Cæsalpinieæ.* Flowers irregular, not papilionaceous; petals spreading, imbricate in æstivation, upper one interior.

3. *Mimoseæ.* Flowers regular; æstivation valvate.

Among the species of the first Sub-family, are Clover, Bean, Pea, Pulse, Liquorice, Cowitch, Laburnum, Broom, Whin; and among the products are Balsams of Peru and Tolu, Gum-Tragacanth, Indigo, African and East Indian Kino, Dragon's-blood, Gum-Lac, Red Sandal-wood, Cabbage-tree bark (*Andira*), Ground-nut, Rose-wood (*Trioptolomea*), Tonka-bean (*Dipterix*). In the second division, are Senna, Tamarind, Carob-tree, also Logwood, Brazil-wood (*Cæsalpinia*), Cane-wood (*Baphia*), Cassia-pulp, Balsam of Copaiva. The third contains the Sensitive-plants, and the various species of *Acacia*, yielding Gum-Arabic, Gum-Senegal, and numerous kindred varieties. (*Leguminosæ*, Juss.)

6. FAMILY.—*Cocoa-plums* (Chrysobalanaceæ). Trees or shrubs; leaves alternate, stipulate; flowers in racemes, panicles, or corymbs, polypetalous or apetalous, nearly regular; calyx 5-lobed, æstivation imbricate; stamens definite or 00; ovary of a single carpel, 1–2-celled; style single, arising from the base; stigma simple; fruit drupaceous, 1-2-celled. Found chiefly in tropical Africa, and America.

7. FAMILY.—*American-Allspice* (Calycanthaceæ). Shrubs; stems square; leaves opposite, exstipulate; flowers axillary, solitary; sepals and petals confounded, imbricated, combined in a fleshy tube; stamens indefinite; ovaries several, 1-celled; style terminal; fruit con-

sisting of nuts enclosed in the fleshy tube of the calyx; cotyledons convolute. Natives of North America and Japan.

IX. ORDER.—DAPHNALS (Daphnales).

Flowers monochlamydeous; carpel solitary; embryo amygdaloidal; albumen none.

1. FAMILY.—*Dodder-Laurels* (Cassythaceæ). Parasitic, climbing, Dodder-like; scales for leaves; perianth 6-parted; stamèns twelve, in four rows, petaloid; anthers 2-celled, bursting by recurved valves; ovary 1-celled; style short; stigma simple; fruit a nut, embedded in the succulent permanent perianth. Found in hot tropical regions.
2. FAMILY.—*Laurels* (Lauraceæ). Trees; leaves mostly alternate, exstipulate; flowers in panicles or umbels; perianth 4-6-cleft; æstivation imbricate; stamens opposite segments of perianth; anthers bursting by longitudinal valves; ovary 1-celled; style simple; stigma obtuse; fruit baccate or drupaceous, naked or covered. Occur in tropical Asia and America, rare in Europe and Africa. Mostly aromatic and fragrant; among their products are Cinnamon and Cassia-bark, True Camphor, Sassafras, Bebeerine (*Nectandra*), Avocados, Brazilian-Nutmegs. (*Laurineæ*, Ventenat.)
3. FAMILY.—*Silver-trees* (Proteaceæ). Shrubs or small

trees; evergreen; leaves opposite or alternate, exstipulate, hard, dry; perianth 4-leaved or 4-cleft; æstivation valvate; stamens four; ovary 1-celled; style simple; stigma undivided, discoid; ovules erect; fruit dehiscent or indehiscent. Natives of Australia and the Cape of Good Hope.

4. FAMILY. — *Mezereons* (Daphnaceæ). Shrubs, rarely herbs; leaves opposite or alternate, exstipulate; flowers capitate or spiked, terminal or axillary; perianth tubular, 4-, seldom 5-cleft; æstivation imbricate; stamens definite; anthers dehiscing lengthways; ovary 1-celled; ovule suspended; style one; stigma undivided; fruit nut-like or drupaceous. Natives of India, North and South America, Australia, the Cape of Good Hope, and Europe. The principal species is "Mezereon." (*Thymelaceæ*, Lindley.)

X. ORDER.—FICOIDALS (Ficoidales).

Flowers monodichlamydeous; corolla, if present, polypetalous; placentæ central or axile; embryo external, curved; albumen mealy, scanty.

1. FAMILY—*Scleranths* (Scleranthaceæ). Herbs; small, inconspicuous; leaves opposite, exstipulate; flowers minute, axillary, sessile; perianth tubular, 4-5-toothed; stamens 1-10; ovary 1-seeded; styles two or one; fruit a membranous utricle enclosed within the

hardened perianth. Inhabit barren fields in Europe, Asia, North America, and some extra-tropical regions of the Southern Hemisphere.

2. FAMILY.—*Aizoons* (Tetragoniaceæ). Herbs or small shrubs; leaves alternate, exstipulate, succulent; flowers small, axillary; perianth 3-5-cleft; stamens definite; ovary 2-9-celled; styles equal to cells of ovary; fruit woody, indehiscent. Occur chiefly in Polynesia, the Cape of Good Hope, and about the Mediterranean.

3. FAMILY.—*Fig-Marigolds* (Mesembryanthemaceæ). Shrubs or herbs, succulent; leaves opposite; flowers terminal, showy; sepals usually five; petals indefinite, coloured; stamens indefinite; ovary usually plurilocular; stigmas numerous, distinct; fruit capsular, mostly many-celled, dehiscence stellate. Natives principally of hot plains at the Cape of Good Hope, but a few occur in Southern Europe, Northern Africa, China, Polynesia, and South America.

4. FAMILY. — *Basellads* (Basellaceæ). Herbs or shrubs, climbing, often succulent; leaves alternate, exstipulate; flowers coloured, naked, sessile or stalked; perianth imbricated, fleshy; stamens opposite divisions of perianth; ovary free, 1-celled; styles several; fruit enclosed in the membranous or succulent perianth; seed erect. All tropical plants, except one doubtful species, which is Siberian.

III. ALLIANCE.—HYPOGYNOUS-EXOGENS (Hypogyneæ).

Flowers mostly hermaphrodite; stamens entirely free from calyx and corolla.

I. ORDER.—PIPERALS (Piperales).

Flowers achlamydeous; embryo minute, at or near the outside of a large quantity of mealy albumen.

1. FAMILY.—*Lizard's-tails* (Saururaceæ). Herbs; leaves alternate, stipulate; flowers in spikes, bisexual, on a scale or bract; stamens 3-6, clavate; ovaries 3-4; ovule erect; stigmas sessile, recurved; fruit either four fleshy indehiscent nuts, or a 1-3-4-celled capsule; embryo lying in a fleshy vitellus. Natives of marshy places in North America, China, and Northern India.
2. FAMILY.—*Chloranths* (Chloranthaceæ). Herbs or under-shrubs, aromatic; stems jointed; leaves opposite, stipulate; petioles sheathing; flowers in terminal spikes, bisexual or unisexual, with a supporting scale; stamens lateral; ovary unilocular; ovule pendulous; stigma simple, sessile; fruit drupaceous, indehiscent; embryo naked; cotyledons divaricate. Natives of India, South America, the West Indies, and the Society Islands.
3. FAMILY.—*Peppers* (Piperaceæ). Shrubs or herbs; stems articulated; leaves mostly opposite, with or without stipules; flowers spiked or racemose, bisexual, supported on a bract;

stamens 2-3-6; ovary 1-celled; ovule erect; stigma sessile, rather oblique; fruit fleshy indehiscent, 1-celled, 1-seeded; embryo in a fleshy vitellus. Inhabit chiefly tropical America and the Indian Archipelago. Among the products are long, black, and white Peppers, Cubebs, Matico, and Betel-Pepper.

II. ORDER.—CHENOPODALS (Chenopodales).

Flowers monochlamydeous; carpels solitary, or if more than one, distinct; placentæ free, central; embryo external, either curved round, or applied to the surface of a little mealy or horny albumen.

1. FAMILY.—*Goose-foots* (Chenopodiaceæ). Herbs or under-shrubs; leaves mostly alternate, exstipulate; flowers small, sometimes unisexual; perianth deeply divided; æstivation imbricated; stamens opposite segments of perianth; anthers 2-celled; ovary 1-celled; style 2-4-divided; stigmas simple; fruit membranous, indehiscent, sometimes baccate. Common in waste districts, more abundant in extra-tropical countries. Comprise Spinage, Beet, Mangold-Wurzel, &c.
2. FAMILY.—*Amaranths* (Amaranthaceæ). Herbs or shrubs; leaves opposite or alternate, exstipulate; flowers in spikes or heads, mostly bisexual; perianth 3-5-partite, scarious, buried in imbricated bracts; stamens distinct or monadelphous; anthers usually 1-celled; ovary unilocular; style 1 or 0; stigma

simple or compound; fruit a membranous utricle or caryopsis, rarely baccate. Found chiefly in dry spots in tropical Asia and America; a few occur also in Africa, Australia, and Europe.

3. FAMILY.—*Surianads* (Surianaceæ). Shrubby; leaves alternate, exstipulate; flowers racemose, bisexual; calyx 5-partite; petals five; stamens indefinite, opposite the sepals; ovary of five carpels, distinct, 1-celled; stigmas simple; pericarp woody; seed solitary, erect, compressed. Contains one genus with a single species. Common on tropical shores.

4. FAMILY.—*Phytolaccads* (Phytolaccaceæ). Undershrubs or herbs; leaves alternate, exstipulate, often dotted; flowers racemose, variously arranged; perianth 4-5-partite; stamens indefinite or alternate with divisions of perianth; ovary of one or several carpels; styles equal to carpels; stigmas simple or divided; fruit baccate or dry, indehiscent. Natives of warm parts of America, Africa, and Asia.

5. FAMILY.—*Marvels-of-Peru* (Mirabilaceæ). Herbs, shrubs, or trees; leaves opposite or alternate; flowers involucrate; perianth tubular, often coloured, becoming indurated at the base; æstivation plaited; stamens definite; ovary 1-celled; style one; stigma one; fruit a caryopsis enclosed within the enlarged tube of the perianth. Occur principally in warm

regions in both worlds. The roots are usually purgative. (*Nyctaginaceæ*, Lindley.)

III. ORDER.—SILENALS (Silenales).

Flowers monodichlamydeous; placentæ free, central; carpels several, combined into a compound fruit; embryo external, curved round a little mealy albumen.

1. FAMILY. — *Buckwheats* (Polygonaceæ). Herbs, rarely shrubs; leaves alternate, mostly stipulate; stipules ochreoid; flowers often unisexual, frequently racemose; perianth divided, often coloured; æstivation imbricated; stamens definite; ovary unilocular, formed of three united carpels; styles and stigmas three; ovule orthotropal; fruit a nut, usually triangular. Distribution very general. Contain much oxalic acid, also nitric, malic, and tannic acids: comprise Sorrel, Buckwheat, and the various species of Rhubarb.

2. FAMILY.—*Purslanes* (Portulacaceæ). Shrubs or herbs, succulent; leaves mostly alternate, exstipulate; flowers axillary or terminal, unsymmetrical, usually ephemeral; sepals two; petals five; stamens variable in number; ovary formed of three united carpels, 1-celled; style single or 0; stigmas several; ovules amphitropal; fruit capsular, 1-celled, dehiscent, or 1-seeded, and indehiscent. Inhabit dry places at the Cape

of Good Hope and in South America, also in Australia.

3. FAMILY.—*Knotworts* (Paronychiaceæ). Herbs or under-shrubs; leaves opposite or alternate, stipules, when present, scarious; flowers minute, symmetrical, with scarious bracts; sepals 3-5; petals minute or 0; stamens generally opposite sepals; ovary usually 1-celled; styles 2-5; ovules amphitropal; fruit small, dry, 1-, rarely 3-celled, indehiscent or opening by three valves. Principally found in Southern Europe and Northern Africa, also in Mexico and at the Cape of Good Hope. (*Illecebraceæ*, Lindley.)

4. FAMILY.—*Pinks* (Dianthaceæ). Mostly herbaceous; stems tumid at the articulations; leaves opposite, exstipulate, often connate; inflorescence usually cymose; flowers bisexual, symmetrical; sepals 4-5, persistent; petals 4-5, unguiculate, or 0; stamens equal to, or double the number of, the petals; ovary of two to five carpels; stigmas 2-5, sessile; ovules amphitropal; fruit capsular, 2-5-valved, 1- or 2-5-celled. Occupy mountainous and waste regions in temperate and cold countries. (*Caryophylleæ*, Juss.)

IV. ORDER.—GERANIALS (Geraniales).

Flowers monodichlamydeous, symmetrical; calyx imbricated; corolla twisted; stamens definite; placentæ axile; embryo with little or no albumen.

1. FAMILY.—*Cranesbills* (Geraniaceæ). Herbs or shrubs; stems tumid; leaves opposite, or alternate and stipulate; flowers usually symmetrical, white, red, yellow, or purple; sepals five, persistent; petals five, unguiculate; stamens monadelphous; ovary of five carpels round an elongated axis; styles five, cohering round the axis; fruit of shells cohering round the torus, and separable from it. Many are found at the Cape of Good Hope, also in Northern Asia, Europe, North America, and Australia. Yield many favourite species for the florist.
2. FAMILY. — *Balsams* (Impatientaceæ). Herbs, succulent, usually annual; leaves alternate or opposite, exstipulate; flowers axillary, irregular, unsymmetrical; sepals five, deciduous; petals five, combined into two or three; stamens five, alternate; ovary 5-celled; stigma sessile; fruit capsular, 5-celled, 5-valved. Natives chiefly of the East Indies. Remarkable for the force with which the seed vessels open at maturity. (*Balsamineæ*, Rich.)
3. FAMILY.—*Wood-Sorrels* (Oxalidaceæ). Herbs, under-shrubs, or trees; leaves alternate, usually exstipulate; flowers symmetrical; sepals five, persistent; petals five, unguiculate, or 0; stamens ten, more or less monadelphous; ovary 3-5-celled; carpels larger than the torus; styles 3-5, filiform; stigmas capitate or slightly bifid; fruit capsular, membranous or fleshy; albumen abundant. Occur in

hot and temperate parts of the world, especially in North America and at the Cape of Good Hope.

4. FAMILY.—*Sarcolenads* (Sarcolænaceæ). Trees or shrubs; flowers fine, showy, usually red, unsymmetrical; involucre 1-2-flowered, persistent; leaves alternate, stipulate; sepals three, small; petals five, convolute; stamens monadelphous; ovary trilocular; style one; stigma trifid; fruit capsular, 3-celled, or by abortion 1-celled; albumen abundant. Natives of Madagascar. (*Chlænaceæ*, Lindley.)

5. FAMILY. —*Flaxes* (Linaceæ). Herbs or small shrubs; leaves alternate or opposite, exstipulate; flowers fugitive; sepals 3 - 4 - 5, persistent; petals 3 - 4 - 5, fugitive; stamens equal to, and alternate with, petals; anthers erect; ovary with as many cells and styles as the sepals; stigmas capitate; ovules pendulous, anatropal; fruit capsular, plurilocular; albumen scanty or 0. Most abundant in Europe and Northern Africa, but occur also in America, India, New Zealand, and Australia. Valuable as being the source of the flax of commerce; yield also Linseed-oil, Linseed-meal, and oil-cake.

V. ORDER.—RUTAls (Rutales).

Flowers monodichlamydeous, symmetrical; calyx and corolla imbricated; stamens definite; placentæ axile; albumen little or none.

1. FAMILY.—*Podostemads* (Podostemaceæ). Herbs; no stomata nor spiral vessels; leaves capillary, linear, lacerated, or minute and imbricated; flowers axillary or terminal, bisexual, naked, or with a more or less perfect perianth, bursting through an irregularly lacerated spathe; stamens definite or indefinite; ovary 2-3-celled; styles or stigmas two or three; fruit slightly pedicellate, capsular, 2-3-valved. Floating plants. Found on rocks, in rivers, and still waters, in South America, and some African Islands.

2. FAMILY. — *Water-peppers* (Elatinaceæ). Herbs, annual; stems fistular, rooting; leaves opposite, stipulate; flowers polypetalous; sepals 3-5; petals alternate with sepals; stamens equal to, or twice as many as, the petals; ovary 3-5-celled; styles 3-5; stigmas capitate; fruit capsular, 3-5-celled, 3-5 valved. Marshy plants, generally distributed.

3. FAMILY. —*Beancapers* (Fabaginaceæ). Herbs, shrubs, or trees; wood very hard; leaves opposite, stipulate; flowers solitary, or in pairs, or threes, white, blue, red, or yellow, regular; calyx 4-5-parted, æstivation convolute; petals alternate with segments of calyx; ovary 4-5-celled; style 4-5-furrowed; stigma simple, or 4-5-lobed; fruit capsular, rarely fleshy, few-seeded, sarcocarp not separable from the endocarp. Chiefly live in warm extra-tropical climes, in South-

ern Europe, Africa, India, Australia, and America. (*Zygophylleæ*, Brown.)

4. FAMILY.—*Quassias* (Simarubaceæ). Trees or shrubs; leaves alternate, exstipulate; flowers usually bisexual, whitish, green, or purple; calyx 4-5-divided; petals 4-5; stamens double the number of the petals; ovary 4-5-lobed, 4-5-celled; style simple; stigma 4-5-lobed; fruit of four or five drupes, arranged round a common receptacle, indehiscent; seeds exalbuminous. Natives of tropical America, Africa, and Asia. Species of *Quassia* and *Simaruba* are employed in medicine.

5. FAMILY.—*Coriariads* (Coriariaceæ). Shrubs; leaves opposite, entire; flowers racemose, terminal and axillary, unisexual; calyx 5-partite, campanulate; petals five, small, alternate with calycine divisions; stamens ten; ovary of five or six carpels; stigmas five, subulate; fruit of five crustaceous carpels, covered by the membranous sepals and fleshy petals, 1-seeded, indehiscent. A small family, inhabiting Southern Europe.

6. FAMILY.—*Ochnads* (Ochnaceæ). Under-shrubs or trees; leaves alternate, stipulate; flowers racemose; sepals five, persistent; petals 5-10, deciduous; æstivation imbricate; stamens 5-10; torus prolonged, succulent; carpels equal in number to petals; styles united in one; fruit of as many pieces as there were carpels, succulent, indehiscent. Natives of

tropical India, Africa, and America; also of the Cape of Good Hope.

7. FAMILY.—*Prickly-Ashes* (Xanthoxyllaceæ). Trees or shrubs; leaves alternate or opposite, exstipulate, dotted; flowers axillary or terminal, unisexual; sepals 3 - 4 - 5, æstivation imbricate; petals 3 - 4 - 5, rarely 0, æstivation imbricate or convolute; stamens as many as, or double the number of, the petals; ovary usually of as many carpels as there are petals, more or less united; ovules sessile, pendulous; styles more or less combined; fruit baccate or membranous, pericarp separable into distinct layers. Chiefly occur in America, but also in Africa, India, China, and Australia.

8. FAMILY.—*Rueworts* (Rutaceæ). Trees or shrubs, rarely herbs; leaves opposite or alternate, exstipulate, dotted; flowers axillary or terminal, bisexual; calyx of 4-5 segments, æstivation imbricate; petal equal to, and alternate with, calycine divisions, or combined below into a gamopetalous corolla, æstivation convolute or valvate; stamens equal to petals, or twice or thrice as many, placed round-a cup-shaped disk; ovary sessile or stalked; ovules sessile, pendulous; styles adherent above; stigmas simple, dilated; fruit of several carpels, combined partially or completely; pericarp separable into two layers. Found in Southern Europe, the Cape of Good

Hope, Australia, and in America. Among the species are Rue (*Ruta*), Bucku (*Barosma*), also *Galidea*, which yields Cusparia or Angostura-bark.

9. Family.—*Connarads* (Omphalobiaceæ). Trees or shrubs; leaves alternate, exstipulate, not dotted; flowers terminal and axillary, in racemes or panicles, rarely unisexual; calyx 5-partite, persistent; petals five; stamens ten; ovary of one or more separate carpels; ovules two, collateral, ascending, orthotropal; styles terminal; stigmas dilated; fruit follicular, dehiscent. Zebra-wood is yielded by this family. (*Connaraceæ*, Brown.)

10. *Sumachs* (Anacardiaceæ). Trees or shrubs; juice resinous, often caustic; leaves alternate, not dotted; flowers terminal or axillary, mostly unisexual; calyx usually 5-divided, small, persistent; petals equal to divisions of calyx; stamens generally equal to, and alternate with, petals; ovary single; ovule solitary, attached by a funiculus to the base of the cell; styles or stigmas 1, 3, or 4; fruit indehiscent, usually drupaceous. Inhabit tropical parts of America, Africa, and India. Among the products, &c., are Cashew-nuts, Pistachio-nuts, Chian-Turpentine, Mastic, Sumach, Japan-Varnish, Mango, Hog's-plums, &c.

11. Family.—*Margosa-plants* (Meliaceæ). Trees or shrubs; leaves mostly alternate, exstipulate;

flowers usually in loose masses; sepals 4-5, more or less united, æstivation imbricate; petals 4-5, connivent at base, æstivation valvate or imbricate; stamens mostly double the number of the petals, monadelphous; disk often large and cup-shaped; ovary single, plurilocular; ovules usually anatropal; style one; stigmas distinct or combined; fruit baccate, drupaceous or capsular; seeds few, wingless. Mostly tropical plants, especially in Asia and America.

12. Family.—*Mahogany-trees* (Cedrelaceæ). Trees; leaves alternate, exstipulate; flowers in terminal panicles; calyx 4-5-cleft; petals 4-5; æstivation imbricated; stamens 8-10, monadelphous or free; ovary 4-5-celled; ovules anatropal; style simple; stigma peltate; fruit capsular, consolidated; seeds numerous, winged. Chiefly important as yielding Mahogany and Satin-wood.

13. Family. — *Frankincense-trees* (Amyridaceæ). Trees or shrubs; leaves opposite or alternate, often stipulate and dotted; flowers axillary or terminal, racemose or panicled, occasionally unisexual; calyx 2-5-divided, persistent; petals 3-5, mostly valvate; stamens twice the number of the petals; ovary 1-5-celled; style solitary; stigmas 1-5; fruit consolidated, dry, hard, indehiscent or valvular. Inhabit tropical India, Africa, and America. A fragrant balsamic family yield-

ing Elemi, Olibanum, Arabian-Frankincense, Myrrh, Balm of Mecca, Balm of Gilead, Bdellium, Incense-wood, &c.

14. FAMILY.—*Orange-plants* (Citraceæ). Trees or shrubs, with numerous receptacles for volatile oil; leaves alternate, articulated with a usually winged petiole, dotted; calyx 3-5-toothed, withering; petals 3-5, imbricated; stamens mostly equal to, or twice as many as, the petals, distinct or combined; ovary free, many-celled; style one; stigma slightly divided; fruit pulpy, one or more celled, with a separable leathery or spongy rind, with numerous receptacles of volatile oil. Yield many edible and refrigerant fruits, as the Orange, Lemon, Lime, Citron, Bergamot, Shaddock, and Forbidden-fruit; and among their other products, are Neroli-oil, Napha-water, &c. (*Aurantiaceæ*, Corr.)

VI. ORDER.—ERICAIS (Ericales).

Flowers dichlamydeous, symmetrical in the ovary; stamens definite; placentæ axile; embryo enclosed in abundant, fleshy albumen.

1. FAMILY.—*Heaths* (Ericaceæ). Shrubs, under-shrubs, or herbs; leaves evergreen, verticillate or opposite, exstipulate; inflorescence variable; calyx 4-5-cleft, persistent; corolla monopetalous, 4-5-cleft; æstivation imbricated; stamens definite; anthers 2-celled, dehiscing by pores; ovary plurilocular, sur-

rounded by a disk or scales ; style and stigma one ; fruit capsular or baccate, multilocular ; placentæ central. Abound at the Cape of Good Hope, but occur also in Europe, North and South America, Asia, and in the Highlands of Java. Some afford an edible fruit, as the Bear-berry. Among the genera are *Erica*, *Calluna*, *Menziesia*, and *Rhododendron*.

2. FAMILY.—*Fir-Rapes* (Monotropaceæ). Parasitic on the roots of Pines and other trees ; stems brown or colourless, with scales instead of leaves ; flowers in terminal spikes or racemes ; sepals 4-5 ; petals 4-5, or monopetalous ; stamens 8-10 ; anthers 2-celled, often dehiscing longitudinally ; ovary 4-5-furrowed ; style short, cylindrical ; stigma succulent, funnel-shaped ; fruit capsular, dry ; seeds 0 0, loose-skinned or winged. Found in cool places in Europe, Asia, and North America.

3. FAMILY.—*Francoads* (Francoaceæ). Herbaceous, stemless ; leaves lobed or pinnate, exstipulate ; inflorescence racemose ; calyx deeply 4-cleft ; petals four, sub-persistent ; stamens free, four times as many as the petals, alternately rudimentary ; ovary 4-celled ; stigma sessile, 4-lobed ; fruit capsular, membranous, 4-valved. Natives of Chili.

4. FAMILY.— *Winter-greens* (Pyrolaceæ). Mostly herbaceous ; flowers terminal and racemose, or solitary ; sepals five, persistent ; corolla

somewhat monopetalous, 4 - 5-parted, deciduous; æstivation imbricated; stamens twice the number of the corolline divisions, free, usually perfect; anthers 2 - celled, dehiscing by pores; ovary 4 - 5-celled; style one; stigma slightly indusiate; fruit capsular, 4-5-celled; seeds 0 0, loose-skinned; embryo at the base of the albumen. Occur in Europe, Northern Asia, and North America. The leaves of *Chimaphila umbellata* are employed in medicine as actively diuretic.

5. Family.—*Epacrids* (Epacridaceæ). Shrubs or small trees; leaves alternate, exstipulate, sometimes half-amplexicaul at the base; flowers in spikes or terminal racemes, or solitary and axillary, usually white or purple; calyx mostly 5-partite, persistent; corolla monopetalous, 5-divided, deciduous; æstivation imbricate or valvate; stamens free, perfect, equal to corolline divisions; anthers 1-celled, opening longitudinally; ovary usually several-celled; style one; stigma simple; fruit drupaceous, baccate, or capsular; seeds firm-skinned. Natives of Australasia and Polynesia, where they appear to represent the Heaths.

6. Family.—*Umiri-Balsams* (Humiriaceæ). Trees or shrubs; leaves alternate, exstipulate; flowers in terminal or axillary cymes, or corymbs; calyx 5-divided; petals alternate with calycine divisions; stamens generally

four times as many as the petals, monadelphous; anthers 2-celled, with a long membranous connective; ovary 5-celled; style simple; stigma 5-lobed; fruit drupaceous, 5-celled; seed with a membranous integument. Natives of tropical America.

VII. ORDER.—BERBERALS (Berberales).

Flowers monodichlamydeous, unsymmetrical in the ovary; stamens definite; placentæ sutural, parietal, or axile; embryo enclosed in abundant, fleshy albumen.

1. FAMILY.—*Cyrillads* (Cyrillaceæ). Shrubs; leaves evergreen, exstipulate; flowers usually racemose; calyx 4-5-partite; petals five, distinct; æstivation imbricated; stamens 5-10; ovary 2-3-4-celled; ovules pendulous; placentæ axile; style short; stigmas with as many lobes as there are cells in the ovary; fruit capsular and succulent, or drupaceous. Natives of North America.

2. FAMILY.—*Placads* (Olacaceæ). Trees or shrubs; leaves alternate, exstipulate; flowers small, axillary, often fragrant; calyx gamosepalous, æstivation imbricate; petals 3-6, æstivation valvate; stamens some fertile, some sterile, the former 3-10, alternate with the petals, the latter opposite the petals; ovary 1-3-4-celled; ovules pendulous; placentæ axile; style filiform; stigma simple; fruit drupaceous, indehiscent, often surrounded by the

enlarged calyx. Mostly confined to the East Indies, Australia, and Africa.

3. FAMILY.—*Canella-Barks* (Winteraniaceæ). Shrubby, aromatic; leaves evergreen, alternate, exstipulate; flowers purple, corymbose; calyx leathery, sepals three, persistent, imbricate; petals 5, æstivation twisted; stamens definite; anthers 2-celled; ovary 1-celled; ovules anatropal; stigma slightly emarginate; fruit 3-celled(?) Comprises two genera, one of which is Brazilian, the other, *Canella*, from the West Indies is officinal.

3. FAMILY.—*Pittosporads* (Pittosporaceæ). Trees or shrubs; leaves alternate, exstipulate; flowers terminal or axillary; sepals and petals 4-5; æstivation imbricate; stamens 5, alternate with the petals; ovary single, 2-5-celled; style 1; stigmas 2-5; ovules ascending or horizontal; placentæ axile and parietal; fruit capsular or baccate. Chiefly occur in Australasia and Polynesia, also in Japan, China, Africa, and the Madeiras.

5. FAMILY.—*Vines* (Vitaceæ). Shrubs, climbing; wood with numerous dotted ducts; abound with sap at certain seasons; lower leaves opposite, upper alternate, stipulate or exstipulate; floral peduncles racemose; flowers small, green, in thyrses, umbels, or panicles; calyx small; petals 4-5; æstivation valvate; stamens 4-5, opposite the petals; anthers versatile; ovary 2-6-celled; ovules anatro-

pal; placentæ axile; style one; stigma simple; fruit round, pulpy. Inhabit the temperate and hotter parts of both hemispheres. Valuable as yielding the Grape-Vine and its various products, as Grapes, Raisins, Currants, and Wine. (*Viniferæ*, Juss.; *Ampelideæ*, Kunth.)

6. FAMILY.—*Berberries* (Berberidaceæ). Shrubs or herbs; leaves alternate, exstipulate; flowers in racemes or panicles; sepals 3-4-6, deciduous; petals equal to, or twice as many as, sepals; stamens equal and opposite to petals; anther-valves recurved; carpel 1-celled; ovules anatropal; placentæ sutural; style sometimes lateral; stigma orbicular; fruit baccate or capsular. Occur chiefly in mountainous districts of northern temperate regions, but also in South America.

7. FAMILY.—*Fumitories* (Fumariaceæ). Herbaceous, with a watery juice; leaves alternate, multifid; flowers irregular, purple, white, or yellow; sepals two, deciduous; petals four, cruciate very irregular; stamens four, distinct, or six, diadelphous; ovary 1-celled; ovules amphitropal; placentæ parietal; style filiform; stigma with two or more points; fruit an achænium, or capsular and 2-seeded, or a many-seeded pod. Occur principally in northern temperate climes.

8. FAMILY.—*Sundews* (Droseraceæ). Herbaceous, delicate; leaves alternate, stipulate; verna-

tion circinnate; sepals five, persistent; petals five; æstivation imbricate; stamens equal to, and alternate with, the petals, or ten, or more; ovary single; styles 3-5; ovules anatropal; placentæ parietal; fruit capsular, 3-5-valved. Inhabit marshy spots in North and South America, South Africa, Madagascar, India, China, Australia, and Europe. Some possess irritable hairs on the leaves, as *Dionœa muscipula*, called Venus' Fly-trap, the opposite laminæ of the leaves of which suddenly close when the hairs are touched, enclosing small insects or other rude aggressors.

VIII. ORDER.—RANALS (Ranales).

Flowers monodichlamydeous; stamens indefinite; placentæ sutural or axile; embryo minute, enclosed in abundant fleshy or horny albumen.

1. FAMILY. — *Poppies* (Papaveraceæ). Herbs or shrubs; often milky; leaves alternate, exstipulate; peduncles long, 1-flowered; flowers dimerous or trimerous, never blue; sepals 2-3, deciduous; petals usually four, cruciate; anthers dithecal; ovary 1-celled; placentæ parietal; ovules anatropal; style short, or none; stigmas two or many; fruit pod-shaped with two, or capsular with several parietal placentæ. Chiefly a European family, but occurring also in Siberia, China, Japan, Australia, the Cape of Good Hope, and tropical America. The most important

plant is *Papaver somniferum*, the concrete milky juice from the unripe capsules of which constitutes opium.

2. FAMILY.—*American Pitcher-plants* (Sarraceniaceæ). Herbaceous, perennial; leaves radical; petioles folded and coherent, forming hollow tubes; scapes one or more flowered; sepals and petals five, or perianth 4-6-leaved; anthers dithecal; ovary 3-5-celled; ovules anatropal; placentæ axile; style single; stigma persistent; fruit capsular, 2-5-celled. Occur in North American marshes, and also in Guiana.

3. FAMILY.—*Cephalotads* (Cephalotaceæ). Herbaceous; stemless; leaves radical, exstipulate; scape with a compound, terminal spike; flowers small; perianth coloured, 6-parted; æstivation valvate; stamens twelve; carpels six, distinct, 1-seeded; ovule erect; fruit consisting of membranous achænia. Contains a solitary Australian genus.

4. FAMILY. — *Crowfoots* (Ranunculaceæ). Herbs, rarely shrubs; leaves alternate or opposite, with dilated, sheathing petioles; inflorescence variable; flowers usually conspicuous; sepals 3-6, deciduous, æstivation mostly imbricate; petals 3-15, rarely abortive; stamens very rarely definite; carpels numerous, 1-celled, distinct, or united into a single many-celled pistil; ovary one or more seeded; ovules anatropal; styles simple; fruit dry

achænia, or baccate, or follicular; albumen horny; seeds exarillate. Chiefly occur in Europe, but found also in North America, and sparingly in South America, Africa, India, and New Holland. Most of the plants are more or less poisonous, as the species of *Ranunculus*, Aconite, Stavesacre, Black-Hellebore, &c.

5. FAMILY.—*Dilleniads* (Dilleniaceæ). Trees, shrubs, or under-shrubs, rarely herbs; leaves alternate, exstipulate; flowers in terminal racemes, or in panicles, often yellow; sepals five, persistent; petals five, imbricated; stamens distinct or polyadelphous; filaments dilated at the base or apex; ovaries definite, more or less distinct; ovules anatropal; style terminal; stigma simple; fruit of 2-5-capsular or baccate unilocular carpels, which are distinct or coherent; albumen fleshy; seeds arillate. Inhabit Australasia, India, Central America, and also Equinoctial Africa.

6. FAMILY.—*Custard-Apples* (Anonaceæ). Trees or shrubs; leaves alternate, exstipulate; flowers axillary, solitary, or two or three together, green or brown; sepals 3-4, persistent, often partially coherent; petals six; æstivation valvate; stamens packed closely together; carpels usually numerous, separate or coherent; ovules anatropal; styles short; stigmas simple; fruit succulent or dry, the carpels 1- or many-seeded, distinct or united; seeds

sometimes arillate; albumen ruminate. Inhabit tropical countries in both hemispheres. Some yield edible fruits, as the Custard-apples from species of *Anona.* Lance-wood is obtained in Guiana from *Duguetia quitarensis.*

7. **Family.**—*Magnoliads* (Magnoliaceæ). Trees or shrubs; leaves alternate, stipules deciduous, convolute; flowers solitary, often odoriferous; sepals 2-6, deciduous; petals 2-30, imbricate; stamens distinct; carpels numerous, 1-celled; ovules anatropal; styles short; fruit dry or succulent, of numerous carpels, which are distinct or partially cohering; albumen fleshy; seeds frequently arillate. Principally inhabit North America, but also South America, the West Indies, New Zealand, Australia, Japan, China, and the East Indies. The most important product is "Winter's-Bark," which is used medicinally.

IX. ORDER.—NYMPHALS (Nymphales).

Flowers dichlamydeous; stamens indefinite; placentæ axile or sutural; embryo on the outside of abundant albumen, or if exalbuminous, the seeds have a large plumule.

1. **Family.**—*Sacred-Beans* (Nelumbiaceæ). Herbs; leaves peltate, floating; trunk prostrate; flowers showy; sepals 4-5; petals numerous; stamens in several rows; filaments petaloid; torus large, fleshy, elevated, enclosing in hollows of its surface numerous 1-

seeded carpels; style very short; stigma simple; ovule anatropal; nuts numerous, half buried in the hollows of the torus; albumen none. Found in quiet waters in temperate or tropical regions, especially in India. Said to have disappeared from Egypt, where it was formerly common. The flower of *Nelumbium speciosium* is supposed to have been the "Lotus" of the ancient Egyptians and Indians, and its fruit to have been the "Egyptian Bean" of Pythagoras.

2. FAMILY.—*Water-shields* (Cabombaceæ). Herbaceous; leaves floating, peltate; flowers axillary, solitary, yellow or purple; sepals 3-4; petals 3-4, alternate with the sepals; stamens definite or indefinite; torus inconspicuous; carpels two, or more; ovules orthotropal; stigmas simple; fruit indehiscent, tipped with the indurated styles; albumen abundant. American aquatic plants; but said to occur also on the coast of New-Holland.

3. FAMILY.—*Water-lillies* (Nymphæaceæ). Herbs; trunk prostrate; leaves fleshy, peltate or cordate; flowers showy, often sweet-scented; sepals usually four, persistent, sometimes confounded with the petals; petals numerous, deciduous, often passing gradually into stamens; stamens numerous; filaments petaloid; torus large, fleshy; ovary many-celled; ovules anatropal; placentæ dissepimental; stigmas radiating; fruit many-celled, inde-

hiscent; albumen farinaceous. Aquatic, floating plants. Common throughout the northern Hemisphere, but rare in the southern; in South America they are represented by the gigantic *Victoria Regina.*

X. ORDER.—GUTTIFERALS (Guttiferales).

Flowers monodichlamydeous; calyx imbricated; corolla imbricated or contorted; stamens indefinite; placentæ axile; albumen little or none.

1. FAMILY.—*Reaumuriads* (Reaumuriaceæ). Shrubby; leaves alternate, exstipulate, scale-like, glandular; calyx 5-partite; petals five, unequal-sided; stamens definite or indefinite, monadelphous or polyadelphous; anthers introrse; carpels free, 2-4-5; ovules anatropal; styles long, distinct; fruit capsular, 2–5-valved, 2–5-celled; seeds definite, shaggy. Occur on the coasts of the Mediterranean, and in salt plains in mild parts of Northern Asia.

2. FAMILY.—*Tutsans* (Hypericaceæ). Herbs, shrubs, or trees; juice resinous; leaves usually opposite, exstipulate, dotted; inflorescence variable; flowers yellow, red, or white; sepals 4-5, persistent, unequal; petals 4-5, oblique, often with black dots; æstivation contorted; stamens usually polyadelphous; carpels 2-5; ovules mostly anatropal; styles long, usually distinct; stigmas truncate or capitate; fruit capsular, dry or fleshy, many-valved, many-

celled; seeds numerous, naked. Distribution general.

3. FAMILY.—*Marcgraaviads* (Marcgraaviaceæ). Trees or shrubs; leaves alternate, exstipulate; flowers in umbels, racemes, or terminal spikes, usually bracteate; sepals 2-7, persistent; corolla of five petals, or gamopetalous; filaments dilated at the base; anthers versatile; ovary 1- or many-celled; style single; stigmas simple; fruit succulent, capsular, or coriaceous, dehiscent or indehiscent; seeds numerous, minute. Natives of Equinoctial America; a doubtful genus (*Antholoma*), is found in New Caledonia.

4. FAMILY.—*Gamboges* (Clusiaceæ). Trees or shrubs; juice resinous; leaves opposite, exstipulate; flowers axillary or terminal, articulated with the peduncle, occasionally unisexual, white, pink, or red; sepals 2-5-6-8, usually persistent, often unequal; petals equals to, or a multiple of, the sepals; stamens rarely definite; anthers adnate, beakless; ovary 1- or many-celled; ovules orthotropal or anatropal; style none or very short; stigmas sessile or nearly so, radiate; fruit dry or fleshy, dehiscent or indehiscent; seeds definite. Natives of tropical countries, principally South America. The principal products of this family are the various kinds of Gamboge, yielded by species of *Hebradendron* and *Garcinia*. (*Gutteferæ*, Juss.)

5. FAMILY. — *Souari-nuts* (Caryocaraceæ). Large trees; leaves opposite, exstipulate, digitate; flowers large, racemose; sepals 5-6, more or less combined; petals 5-8; æstivation imbricate; stamens slightly monadelphous; anthers roundish; ovary 4–5-celled; ovules semi-anatropal; stigmas sessile; fruit of several indehiscent, 1-celled, 1-seeded nuts, with a thick double endocarp; embryo with a very large radicle. Inhabit warm South American forests. Souari-nuts are produced by *Caryocar butyrosum.*

6. FAMILY.—*Tea-plants* (Ternströmiaceæ). Trees or shrubs; leaves alternate, exstipulate, occasionally dotted; peduncles axillary or terminal; flowers usually white; sepals 5-7, deciduous; petals 5-6-9, often combined at the base; anthers versatile or adnate; ovary multilocular; styles 2-7, more or less combined; fruit capsular, 2–7-celled, opening by valves, or coriaceous and indehiscent; seeds few, large. Abundant in North and South America, India, and China. The principal plant is that affording Tea, now in this country, become quite a necessary of life. It is not quite settled whether the varieties of tea, namely, the green and the black, are the products of one or of different species. (*Theaceæ,* Mirbel.)

7. FAMILY.—*Scrubby-Oaks* (Lophiraceæ). Trees; bark dry; leaves alternate; stipules very

small, deciduous; flowers axillary and terminal, panicled, yellow; peduncles bracteate; sepals five, unequal; petals five; æstivation contorted; anthers adnate; ovary 1-celled; ovules indefinite; stigmas two, very small, twisted; nut coriaceous, 1-celled, consolidated with the enlarged calyx. Contains one tropical African genus.

8. FAMILY.—*Borneo-Camphors* (Dipterocarpaceæ). Large trees; juice resinous; leaves alternate, vernation involute, stipules deciduous; flowers large, racemes terminal and panicled, or axillary and solitary; calyx tubular, 5-lobed, unequal, persistent; petals sessile, often combined at the base, æstivation twisted; anthers innate, subulate; ovary 3-celled; style and stigma simple; fruit coriaceous, 1-celled, 3-valved, or indehiscent. Natives of India and the Indian Archipelago. Among the products are Borneo-Camphor, Gum-Animi, Piney-Varnish, Wood-Oil, &c. (*Dipteraceæ*, Lindley.)

XI. ORDER.—SAPINDALS (Sapindales).

Flowers monodichlamydeous, unsymmetrical; calyx and corolla imbricate; stamens definite; placentæ axile; albumen little or none.

1. FAMILY.—*Erythroxyls* (Erythroxylaceæ). Shrubs or trees; leaves alternate, stipulate; flowers small; peduncles axillary, solitary or clustered; sepals five, persistent; petals five, with a

small scale at the base; stamens ten, monadelphous; ovary 3-celled; styles three, distinct or united; stigmas three, capitate; ovules sessile, pendulous; fruit drupaceous, 1-seeded; embryo straight; albumen sometimes none. Natives of South America and the West Indies; but occur sparingly also in the East Indies, the Isle of France, Madagascar, and in New Holland.

2. FAMILY.—*Malpighiads* (Malpighiaceæ). Trees or shrubs; leaves mostly opposite, stipulate; hairs, when present, peltate; inflorescence variable; flowers unisexual or bisexual, mostly red or yellow; calyx 5-partite, persistent, æstivation usually quincuncial; petals five, æstivation convolute; stamens generally ten, often monadelphous; ovary of three carpels, more or less combined; ovules with a long pendulous cord; styles three, distinct or united; stigmas three, simple; fruit drupaceous, nut like, or samaroid; embyro convolute. Tropical plants, mostly South American and West Indian, occur also in Africa, Arabia,India, China, and Polynesia.

3. FAMILY.—*Maples* (Aceraceæ). Trees; leaves opposite, exstipulate; flowers often polygamous, axillary, corymbose or racemose; calyx mostly 5-divided; petals five, or 0; stamens generally eight; ovary 2-lobed, 2-celled; ovules amphitropal, pendulous; style one; stigmas two; fruit samaroid; seeds exarillate;

embryo curved. Occur in Europe, temperate parts of Asia, and North America. Among the species are the Sugar-Maple, and the Sycamore, or Great-Maple.

4. FAMILY. — *Guinea-hen Weeds* (Petiveriaceæ). Under-shrubs or herbs; odour often alliaceous; leaves alternate, stipulate, often dotted; flowers racemose or panicled, apetalous; perianth of several distinct leaves; stamens often indefinite; ovary 1-celled; ovule erect; style one; stigma lateral; fruit 1-celled, indehiscent, wingless or winged; embryo usually straight. Natives of tropical America or the West Indies.

5. FAMILY. — *Soap-Worts* (Sapindaceæ). Trees, twining shrubs, or rarely herbs; leaves alternate, exstipulate, often dotted; flowers in racemes or racemose panicles, small, mostly white or pink; calyx 4–5-partite, or 4–5-leaved; petals 4-5, naked, or with an appendage inside; stamens 8–10, sometimes 5-6-7, rarely 20; disk fleshy; ovary 3-celled; ovules anatropal; style undivided, or 2–3-cleft; fruit capsular, and 2–3-valved, or samaroid, or fleshy and indehiscent; seeds usually arillate; embryo curved or twisted. Tropical species; chiefly found in India and South America. Contain many poisonous plants, but yield some edible fruits. Among the products are Soap-berries, Horse-chesnuts, Guaranâ, &c.

6. FAMILY.—*Bladder-nuts* (Staphyleaceæ). Shrubs; leaves opposite, stipulate; flowers racemose, terminal, stalked; sepals five, coloured; petals and stamens five, alternate; disk large, urceolate; ovary 2–3-celled; ovules usually ascending; styles 2-3, coherent at the base; fruit membranous or fleshy, indehiscent or opening internally; albumen little or none. Distribution irregular, in Europe, North and South America, the West Indies, India, and Japan.

7. FAMILY.—*Vochysiads* (Vochysiaceæ). Trees or shrubs; leaves opposite, stipulate; flowers in terminal panicles or racemes; sepals 4-5, unequal; petals 1-2-3-5, alternate, equal; stamens 1-5, usually opposite, one having an ovate, fertile, 4-celled anther, and the others barren; ovary 3-celled; ovules amphitropal or anatropal; style and stigma 1; fruit capsular, triquetrous, 3-celled, 3-valved; embryo straight. Inhabit equinoctial America. (*Vochyaceæ*, Lindley.)

8. FAMILY.—*Milk-Worts* (Polygalaceæ). Shrubs or herbs; leaves alternate or opposite, exstipulate; flowers usually racemose; pedicels with three bracts; sepals five, distinct, very irregular; petals three or five, unequal; stamens usually eight, monadelphous or diadelphous; anthers 1-celled, dehiscence by pores; ovary mostly 2-celled; ovules anatropal; style and stigma simple; fruit indehiscent, or with loculicidal dehiscence; seeds carunculate; albumen abun-

dant; embryo straight. Distribution general. Among the products are Snake-root (*Senega*) and Rhatany-root (*Krameria*). (*Krameriaceæ*, Martius.)

9. Family.—*Pore-Worts* (Tremandraceæ). Shrubs; slender, heath-like; leaves alternate or verticillate, exstipulate; pedicels 1-flowered; sepals 4-5, equal, deciduous, æstivation valvate; petals 4-5; æstivation involute; stamens 8-10; anthers 2-4-celled, dehiscence porous; ovary 2-celled; ovules anatropal; styles and stigmas 1-2; fruit capsular, 2-celled, 2-valved; embryo cylindrical; albumen fleshy. An Australian family.

XII. ORDER.—Malvals (Malvales).

Flowers monodichlamydeous; calyx valvate; corolla imbricated or twisted; stamens definite or indefinite; placentæ axile; albumen little or none.

1. Family.—*Linden-blooms* (Tiliaceæ). Trees or shrubs, rarely herbs; leaves alternate, stipulate; sepals and petals 4-5; stamens generally indefinite and distinct; ovary of 2-10 carpels; style one; stigmas as many as the carpels; ovules anatropal; fruit dry or pulpy, often prickly; embryo straight; albumen fleshy. Tropical plants. Russian mats are made from the inner bark of the Linden-tree.

2. Family.—*Mallows* (Malvaceæ). Herbs, shrubs, or trees; leaves alternate, stipulate; hairs, if present, stellate; peduncles usually axillary;

flowers showy; sepals five, rarely three or four; petals equal in number to the sepals; æstivation twisted; stamens 0 0, all perfect; filaments monadelphous; anthers 1-celled, dehiscence transverse; ovary of several carpels united round a common axis; styles as many as carpels; stigmas variable; fruit capsular or baccate; embryo curved; albumen none. Abundant in tropical and in warmer temperate climes. Common-Mallow (*Malva*) and Marsh-Mallow (*Althæa*) are used medicinally; but by far the most important genus is *Gossypium*, the source of the cotton of commerce.

3. FAMILY.—*Indian-Cresses* (Tropæolaceæ). Herbaceous, smooth; leaves alternate, exstipulate; peduncles axillary, 1-flowered; flowers showy; sepals 3-5, the upper spurred; petals 1-5, more or less unequal; stamens 6-10, distinct; disk none; ovary of 3 or 5 carpels; style single; stigmas 3-5, acute; ovules erect or pendulous; fruit indehiscent, usually of three pieces; seeds exalbuminous; embryo large. Natives of temperate parts of North and South America.

4. FAMILY.—*Vivianiads* (Vivianiaceæ). Herbaceous or suffruticose; leaves opposite or verticillate, exstipulate, often downy; flowers in panicles or corymbs; calyx 10-ribbed, 5-divided; petals five; persistent; æstivation twisted; stamens ten, distinct; disk none; ovary 3-

celled; stigmas three, sessile; fruit capsular, 3-celled, 3-valved; embryo curved; albumen fleshy. Natives of Southern Brazil and of Chili.

5. FAMILY.—*Cacao-plants* (Byttneriaceæ). Trees, shrubs, or under-shrubs; leaves alternate; stipules deciduous or 0; flowers in clusters, spikes, or panicles; calyx 4–5-lobed; petals 4–5, or 0; stamens equal to, or some multiple of, the petals, more or less monadelphous, some sterile; anthers 2-celled, introrse; ovary of 4–10 carpels; ovules anatropal; styles terminal, as many as the carpels; fruit capsular; embryo straight or curved; albumen fleshy. Chiefly tropical or sub-tropical plants in Asia, Africa, America, and Australasia. The principal plant is the Cacao-tree (*Theobroma Cacao*), yielding chocolate and cocoa.

6. FAMILY.—*Silk-cotton Plants* (Sterculiaceæ). Trees or shrubs; leaves alternate, stipules deciduous; inflorescence variable; flowers occasionally unisexual; calyx naked or involucrate, sepals five; petals five or 0; stamens indefinite, perfect, monadelphous; anthers 2-celled, extrorse; pistil of five, rarely three, carpels, distinct or cohering; ovules orthotropal or anatropal; fruit capsular, follicular, or succulent; embryo straight or curved; albumen oily or fleshy. Distribution tropical, extensive. This family boasts of one of the largest trees

known, namely, the Baobab-tree of Senegal (*Adansonia digitata*).

XIII. ORDER.—CISTALS (Cistales).

Flowers monodichlamydeous; placentæ parietal or sutural; embryo curved or spiral; albumen little or none.

1. FAMILY.—*Caper-plants* (Capparidaceæ). Herbs, shrubs, or trees; leaves alternate, exstipulate, or with spines at the base; flowers solitary or racemose; sepals four, often partially coherent; petals 4-8 or 0, usually unequal; stamens 4-6 or 0 0, on an elongated hemispherical torus; ovary 1-celled; placentæ parietal; ovules amphitropal or campylotropal; style 0, or filiform; stigma generally round; fruit pod-shaped and dehiscent, or fleshy and indehiscent; seeds exalbuminous; embryo curved. Tropical genera widely distributed, but especially abundant in Africa. Mostly stimulant; the flower-buds of *Capparis spinosa* constitute "capers."
2. FAMILY.—*Mignonettes* (Luteolaceæ). Herbs, rarely shrubs; leaves alternate, stipules minute, gland-like; flowers in racemes or spikes; calyx many-parted; petals 4-6, unequal; torus glandular; stamens 10-24; ovary 3-lobed, 1-celled; placentæ parietal; ovules amphitropal or campulitropal; stigmas three; fruit dry and membranous, or succu-

lent, opening at the point; seeds exalbuminous; embryo taper. Inhabit Europe and Western Asia, also Southern Africa and California. (*Resedaceæ*, De Cand.)

3. FAMILY. — *Cruciferous - plants* (Brassicaceæ). Herbs, rarely under-shrubs; leaves alternate; flowers generally racemose, usually yellow or white; sepals four, deciduous, valvate or imbricate; petals four, cruciate, alternate; stamens six, tetradynamous; torus glandular; ovary 1-celled; placentæ parietal; stigmas two; fruit a silique or a silicule, 1-celled, usually dehiscing by two valves; albumen none. Chiefly European, but found also more sparingly in most temperate and sub-tropical countries. Most are anti-scorbutic; comprise many well-known plants, as the Cabbage, Cauliflower, Turnip, Radish, Cress, Horse-radish, Mustard, Scurvy-grass, Woad, &c. (*Cruciferæ*, Juss.)

4. FAMILY.—*Rock - Roses* (Cistaceæ). Shrubs or herbs; leaves opposite or alternate, stipulate or exstipulate; flowers racemose, white, yellow, or red, very fugacious; sepals 3–5, persistent, unequal; petals five, rarely three, caducous, twisted in an opposite way to that of the sepals; stamens usually indefinite, distinct; ovary syncarpous, 1- or many-celled; ovules orthotropal; style single; stigma simple; fruit capsular, 3-5-10-valved; embryo inverted, spiral or curved; albumen horny.

Chiefly inhabit Southern Europe and Northern Africa.

XIV. ORDER.—VIOLALS (Violales).

Flowers monodichlamydeous; placentæ parietal or sutural; embryo straight; albumen little or none.

1. FAMILY.—*Turnerads* (Turneraceæ). Herbaceous or shrubby; leaves alternate, exstipulate; flowers axillary; calyx 5-lobed, equal, æstivation imbricate; petals five, mostly yellowish, perigynous, equal, æstivation twisted; stamens five, alternate; ovary 1-celled; placentæ parietal; ovules 00, anatropal; styles more or less coherent, or forked; stigmas multifid; fruit capsular, 1-celled, 3-valved; albumen fleshy. Found in South America and the West-Indies.
2. FAMILY—*House-leeks* (Crassulaceæ). Herbs or shrubs, often succulent; leaves entire or pinnatifid, exstipulate; flowers in cymes; sepals 3-20; corolla gamopetalous, or petals 3-20; stamens equal to, or twice as many as, petals; carpels same number as petals; ovules 00, anatropal; styles several or combined; stigmas pointed or 4-cornered; fruit of several follicles; albumen fleshy. Distribution extended, occurring in very dry situations, as on rocks, walls, &c.
3. FAMILY.—*Sauvagesiads* (Sauvagesiaceæ). Shrubs or herbs; leaves alternate, stipulate; flowers terminal, in panicles or racemes, light-coloured; sepals, five, imbricated; petals five;

æstivation convolute; stamens definite and fertile, or indefinite, partly fertile and partly petaloid; anthers extrorse; ovary 1-celled; ovules anatropal; placentæ parietal; style terminal; stigma simple; fruit capsular, 3-valved; albumen fleshy. Natives of South America and the West Indies.

4. FAMILY.—*Tamarisks* (Tamaricaceæ). Shrubs or herbs; leaves alternate, scale-like; flowers racemose or spiked; calyx 4–5-partite; petals 4-5; æstivation imbricate; stamens equal to, or twice as many as, the petals, distinct or monadelphous; anthers introrse; ovary 1-celled; styles three; ovules anatropal; fruit capsular, 3-valved, 1-celled; seeds numerous, comose; albumen none. Peculiar to the Eastern half of the Northern Hemisphere. Mount Sinai manna is obtained from *Tamarix mannifera.*

5. FAMILY.—*Frankeniads* (Frankeniaceæ). Herbs or under-shrubs; leaves opposite, exstipulate; flowers sessile, terminal; sepals 4-5, cohering into a furrowed tube; petals 4-5, alternate; stamens usually equal to, and alternate with, petals; anthers versatile; ovary 1-celled; ovules anatropal; placentæ parietal; style filiform; fruit capsular, 1-celled, 2-3-4-valved; seeds numerous; albumen fleshy. Natives of Southern Europe and Northern Africa, also of the Cape of Good Hope and Australia.

6. FAMILY.—*Violets* (Violaceæ). Herbs or shrubs;

leaves mostly alternate, stipulate; vernation involute; inflorescence various; sepals five, persistent, equal; æstivation imbricated; petals five, equal or unequal; æstivation obliquely convolute; stamens five, alternate; anthers introrse; filaments dilated; ovary 1-celled; ovules anatropal; placentæ parietal; style single; stigma oblique-hooded; fruit capsular, 3-valved; albumen fleshy. The herbaceous species are more abundant in northern temperate countries, while those which are shrubby inhabit South America and India.

7. FAMILY.—*Ben-nuts* (Moringaceæ). Trees; leaves 2–3-pinnate, stipulate; flowers irregular, in loose panicles; calyx 5-partite; petals five, unequal; stamens 8-10, perigynous; filaments rather petaloid; anthers 1-celled; ovary 1-celled; placentæ parietal; ovules anatropal; style filiform; stigma simple; fruit capsular, pod-like, 1-celled, 3-valved; seeds numerous; albumen none. Natives of Arabia and India. The seeds of *Moringa pterygosperma* are the "Ben-nuts" of authors; they yield a fluid oil named "Oil of Ben."

8. FAMILY.—*Crown-worts* (Malesherbiaceæ). Herbs or half-shrubs; leaves alternate, exstipulate; flowers axillary or terminal, solitary; calyx tubular, 5-lobed; æstivation imbricate; petals five, alternate, coronetted, persistent, æstivation convolute; stamens 5-10, perigynous;

anthers versatile; ovary 1-celled; placentæ parietal; ovules anatropal; styles three, very long, dorsal; stigmas clavate; fruit capsular, 1-celled, 3-valved; seeds exarillate; albumen abundant. Natives of Peru and Chili.

9. FAMILY—*Passion-flowers* (Passifloraceæ). Herbs or shrubs, generally climbing; leaves alternate, stipulate; flowers axillary or terminal; sepals five; petals usually five, perigynous; æstivation imbricate; stamens five, monadelphous, surrounding the stalk of the ovary; anthers extrorse; ovary 1-celled; ovules anatropal; placentæ parietal; styles three, clavate; stigmas dilated; fruit stipitate, 1-celled, often 3-valved; seeds arillate; albumen fleshy. Chiefly occur in South America and the West Indies; found also in North America, Africa, and the East Indies.

10. FAMILY. — *Samyds* (Samydaceæ). Trees or shrubs; leaves alternate, evergreen, stipulate, with linear, pellucid dots; peduncles axillary, solitary or numerous; perianth 4-5-divided, usually coloured inside; æstivation somewhat imbricate; stamens arising from tube of perianth, two, three, or four times as many as its divisions, all fertile or the alternate ones sterile; filaments monadelphous at the base; anthers 2-celled; ovary 1-celled; ovules semi-anatropal; placentæ parietal; style filiform; stigma capitate or slightly lobed; fruit coriaceous, capsular, 1-celled,

3–5-valved; seeds arillate; albumen oily or fleshy. Principally from tropical America; a few are African or Asiatic.

11. FAMILY.—*Lacistemads* (Lacistemaceæ). Shrubs or small trees; leaves alternate, exstipulate (?); flowers amentaceous, polygamous; perianth in several narrow divisions, covered by an enlarged bract; stamen one, unilateral; anther 2-celled (?); ovary 1-celled; ovules anatropal; placentæ parietal; stigmas 2-3, sessile or on a style; fruit capsular, 1-celled, 2-3-valved; seed arillate; albumen fleshy. Natives of Equinoctial America.

12. FAMILY.—*Bixads* (Flacourtiaceæ). Shrubs or small trees; leaves alternate, exstipulate, often dotted; peduncles axillary, many-flowered; sepals 4-7; petals 4-7, alternate, or none; stamens equal to, or some multiple of, the petals; ovary sessile or nearly so, 1-or more-celled; placentæ parietal; style filiform or none; stigmas several; fruit 1-celled, fleshy and indehiscent, or capsular and 4-5-valved; albumen fleshy. Chiefly occur in hot parts of the East and West Indies and Africa, also at the Cape of Good Hope, and in New Zealand. "Arnotto" is supplied by the reddish pulp surrounding the seeds of *Bixa Orellana*.

II. *SUB-CLASS.*—DICLINOUS-EXOGENS (Diclineæ).

Flowers unisexual, without any customary tendency to hermaphroditism.

I. ORDER.—PAPAYALS (Papayales).

Flowers dichlamydeous; carpels superior, consolidated; placentæ parietal; embryo surrounded by abundant albumen.

1. FAMILY.—*Pangiads* (Pangiaceæ). Trees; leaves alternate; flowers axillary; sepals and petals mostly five; scales equal to, and opposite, the petals; male stamens five or 00, sterile stamens equal to the petals; ovary 1-celled; ovules indefinite; fruit capsular, succulent, indehiscent, 1-celled; seeds 00. Natives of hot parts of India.
2. FAMILY.—*Papaws* (Papayaceæ). Trees or shrubs; leaves alternate; flowers in axillary racemes or solitary; calyx 5-toothed; corolla monopetalous, 5-lobed; scales in throat of female flowers wanting; stamens definite; ovary 1-celled; stigma 3–5-lobed; fruit succulent or dehiscent, 1-celled. Inhabit South America, also temperate and tropical parts of the Old World.

II. ORDER—CUCURBITALS (Cucurbitales).

Flowers monodichlamydeous; fruit inferior; placentæ parietal; embryo without albumen.

1. FAMILY.—*Begoniads* (Begoniaceæ). Herbs or under-shrubs; leaves alternate; stipules large, scarious; flowers cymose, pink; perianth adherent, segments coloured, four in the male, and 4–8 in the female; stamens indefinite; anthers collected in a head; ovary

3-celled; ovules 00, anatropal; placentæ axile; stigmas three, sessile; fruit capsular, membranous, triangular, winged; seeds 0 0. Natives of the East and West Indies, South America, and also Africa.

2. FAMILY. — *Datiscads* (Datiscaceæ). Herbs or trees; leaves alternate, exstipulate; flowers in axillary racemes, or terminal panicles; *male flowers*, perianth 3–4-divided, stamens 3–7; anthers 2-celled; *female*, perianth adherent, 3–4-toothed; ovary 1-celled; ovules 0 0, anatropal; stigmas 3-4, opposite lobes of perianth; fruit capsular, 1-celled; seeds strophiolate. Distribution scattered over North America, Siberia, Northern India, the Indian Archipelago, and South-Eastern Europe.

3. FAMILY.—*Gourds* (Cucurbitaceæ). Herbaceous, climbing by tendrils formed of abortive stipules; leaves alternate, usually palmate; flowers unisexual, light-coloured; calyx 5-toothed; corolla 5-parted; stamens five, distinct, or variously united; anthers 2-celled; ovary adherent, 1-celled; ovules solitary or 00; stigmas very thick; fruit a pepo; seeds flat. Natives chiefly of sub-tropical and warm-temperate regions, especially India. Among the products are the melon, cucumber, gourd, pumpkin, vegetable-marrow, also colocynth and elaterium.

III. ORDER.—MENISPERMALS (Menispermales).

Flowers monodichlamydeous; carpels superior, disunited; embryo surrounded by abundant albumen.

1. FAMILY.—*Moonseeds* (Menispermaceæ). Shrubs, sarmentaceous; wood frequently arranged in wedges; leaves alternate, entire; flowers very small, racemose, often diœcious; sepals and petals undistinguishable, in several rows, deciduous; stamens usually monadelphous; anthers extrorse; carpels solitary or numerous; ovule amphitropal; fruit drupaceous, 1-seeded, oblique or lunate; embryo large, curved or peripherical. Common in tropical Asia and America, a few also in Africa. Yield Calumba-root, Pareira-brava, and Coculus-indicus.
2. FAMILY.—*Kadsurads* (Schizandraceæ). Shrubs, scrambling; leaves alternate, simple, exstipulate, often dotted; flowers small, solitary or axillary; sepals 3–6; petals 3–9, hypogynous; stamens 0 0, monadelphous or free; anthers extrorse; carpels 0 0, free or adherent, 1-celled; ovules 2, pendulous; stigma sessile; fruit numerous, berried, 1-2-seeded; seeds pendulous; embryo very small. Occur in India and the Indian islands, Japan, and hot parts of North America.
3. FAMILY. — *Lardizabalads* (Lardizabalaceæ). Shrubs, twining; leaves alternate, exstipu-

late, compound; flowers racemose, solitary or clustered; sepals 3–6, in two rows; petals six, in two rows, opposite, or 0; stamens six, opposite; anthers mostly extrorse; rudimentary ovaries in male flowers; female flowers larger, with six imperfect stamens; carpels mostly 3, 1-celled; ovules many; style short; stigma simple; fruit short-stalked, berried, usually many-seeded; seeds parietal; embryo minute. Found in temperate parts of South America, and in China.

4. FAMILY.—*Nutmegs* (Myristicaceæ). Trees; leaves alternate, exstipulate, not dotted; inflorescence axillary or terminal, in racemes, glomerules, or panicles; flowers very small, completely unisexual; perianth trifid, rarely quadrifid, deciduous in the female; æstivation valvate; stamens 3–12; filaments often united into a cylinder; anthers extrorse; ovary of one or more carpels; ovule anatropal; style very short; stigma somewhat lobed; fruit succulent, 1-celled, 2-valved; albumen ruminate; embryo small. Natives of tropical India and America. The chief species is ***Myristica officinalis***, affording mace and nutmegs.

5. FAMILY.—*Plume-nutmegs* (Atherospermaceæ). Trees; leaves opposite, exstipulate; flowers axillary, racemose, rarely bisexual; perianth tubular, divided at the top into segments, usually in two rows, the inner petaloid, and

in the females with scales; stamens 0 0, but fewer in the female; anthers 2-celled, with valvular dehiscence; ovaries usually 0 0; ovule erect; style and stigmas simple; fruit consisting of achænia, enclosed within tube of perianth; seed erect; embryo minute. Natives of Australia and of Chili.

6. FAMILY.—*Monimiads* (Monimiaceæ). Trees or shrubs, aromatic; leaves opposite, exstipulate; flowers axillary; perianth somewhat globose, divided at the border; stamens 0 0, perigynous; anthers with longitudinal dehiscence; ovaries several, 1-celled; ovule anatropal; fruit of several 1-seeded achænia, enclosed within the enlarged perianth; seed pendulous; embryo minute, external to the albumen. Mostly occur in South American forests, a few also in Madagascar, the Mauritius, Java, Australia, and New Zealand.

IV. ORDER.—GARRYALS (Garryales).

Flowers monochlamydeous, sometimes amentaceous; fruit inferior; embryo minute, in a large quantity of albumen.

1. FAMILY.—*Helwingiads* (Helwingiaceæ). Shrubby; leaves alternate, stipulate; flowers fascicled; perianth 3-4-partite, segments deciduous in the female; æstivation valvate; stamens 3-4, alternate; anthers introrse; ovary 3-4-celled; ovules anatropal; style very short; stigmas 3-4, subulate; fruit drupaceous, 3-4-

celled; seeds pendulous. A single Japanese genus, with but one known species.

2. FAMILY. — *Garryads* (Garryaceæ). Shrubs; leaves opposite, exstipulate; flowers in pendulous, amentaceous racemes; wood without distinct zones; *male* perianth 4-partite; *female* perianth superior, 2-toothed; stamens four, alternate with segments of perianth; ovary 1-celled; ovules two, pendulous; styles two; fruit baccate, indehiscent; seeds two. Natives of North America and the West Indies.

V. ORDER.—QUERNALS (Quernales).

Male flowers amentaceous, monochlamydeous; fruit inferior; embryo amygdaloid; albumen none.

1. FAMILY.—*Walnuts* (Juglandaceæ). Trees; leaves alternate, not dotted, exstipulate; flowers herbaceous, inconspicuous; *male* flowers amentaceous; perianth membranous, irregularly lobed; stamens 3 or 0 0; anthers erect, 2-celled; *female* flowers in terminal clusters or loose racemes; perianth single or double, the outer 3-5-partite; ovary adherent, 1-celled; ovule erect, orthotropal; styles 1–2; stigmas 2–4, unequal; fruit drupaceous, sometimes with an adherent involucre. Chiefly North American, but a few inhabit Persia, and the East and West Indies. Afford the black and common walnuts, and hickory wood.

2. FAMILY.—*Oaks* (Corylaceæ). Trees or shrubs;

leaves alternate, stipulate; *male* flowers amentaceous; perianth membranous, valvate; stamens 3–20; *female* flowers aggregate or amentaceous; ovary 2- or more celled, crowned by remains of the adherent perianth, seated within a coriaceous involucre; ovules twin or solitary, peltate or pendulous; stigmas several, distinct; fruit bony or membranous, 1-celled, more or less enclosed in the involucre. Inhabit forests in temperate parts of both hemispheres. A very valuable group, embracing the oak, beech, hazel-nut, Spanish-chesnut; and affording, besides excellent timber, cork, gall-nuts, Velonia, Quercitron, nuts, filberts, chesnuts, &c. (*Quercineæ*, Juss. *Cupuliferæ*, Rich.)

VI. ORDER.—Euphorbials (Euphorbiales).

Flowers monodichlamydeous, scattered; carpels superior, consolidated; placentæ axile; embryo large, surrounded by abundant albumen.

1. Family.—*Pitcher-plants* (Nepenthaceæ). Herbs, or half-shrubs; leaves alternate, slightly sheathing at the base, having a dilated, foliaceous petiole, pitcher-shaped at the extremity, with a lid-like lamina; inflorescence racemose, terminal, dense; flowers diœcious; perianth 4-parted; æstivation imbricate; stamens united into a solid column; anthers about sixteen, extrorse; ovary 4-cornered, 4-celled; ovules 0 0; stigma sessile; fruit capsular,

4-celled, 4-valved; seeds 0 0, minute, with a loose testa; radicle inferior. Natives of swamps in the East Indies and China.

2. FAMILY.—*Batids* (Batidaceæ). Shrubs; leaves opposite, exstipulate, succulent; flowers in spikes; *male flowers*, scales of cone 1-flowered; perianth a scale rolled up with its back next the axis, and the edges united; *female flowers* absolutely naked (?), or composed of succulent scales arranged in a 4-rowed cone; stamens four; filaments flattened; ovary 5-6-celled; ovules erect; stigma sessile; fruit succulent. Comprises one genus abundant in West-Indian salt marshes.

3. FAMILY.—*Crowberries* (Empetraceæ). Shrubs, heath-like; leaves evergreen, alternate or partially verticillate, exstipulate; perianth of persistent, imbricated scales, the inner often petaloid; stamens equal to, and alternate with, scales in inner row; anthers 2-celled; ovary seated on a fleshy disk, 3-6-9-celled; ovules definite, ascending, anatropal; style one; stigma with as many radii as there are ovarian cells; fruit a nuculanium, within the persistent perianth; radicle inferior. A small group, inhabiting Europe, North America, and the straits of Magellan. The fruit of *Empetrum nigrum*, the black crowberry, which is not unpleasantly acid, is frequently eaten in Northern Europe.

4. FAMILY.—*Star-worts* (Callitrichaceæ). Herba-

ceous, small; leaves opposite; flowers axillary, very minute, monœcious, naked; stamen hypogynous; filament filiform; anther reniform, 1-celled, 2-valved; ovary 4-cornered, 4-celled; ovules definite, suspended, amphitropal; styles two, subulate; stigmas simple points; fruit 4-celled, 4-seeded, indehiscent; radicle superior. Inhabit still-waters in Europe and North America.

5. FAMILY. — *Scepads* (Scepaceæ). Trees; leaves alternate, stipules membranous; flowers diœcious; *male flowers* amentaceous; perianth 4–5-leaved, imbricated; stamens 2-5; filaments short, not elastic; anthers 2-celled; *female flowers* in short axillary racemes; perianth of six segments in two whorls; ovary 2-celled; style 0; stigma with two short emarginate lobes, or four equal fringed ones; ovules in pairs, pendulous, anatropal; fruit 2-celled, 4-valved; radicle superior. Forest trees in tropical India.

6. FAMILY.—*Gyrostemonads* (Gyrostemonaceæ). Trees or shrubs; leaves alternate, stipulate; *male flowers*, perianth 6–7-lobed; stamens indefinite, distinct; *female flowers*, perianth cup-shaped, 6–7-lobed; carpels 00, round a flat torus, 2-seeded; ovules pendulous, campylotropal; fruit of several membranous cases arranged in a ring; radicle inferior. Natives of New Holland.

7. FAMILY. — *Spurges* (Ricinaceæ). Trees, shrubs,

or herbs, often with acrid milk ; leaves opposite or alternate, often stipulate ; flowers axillary or terminal, variously arranged, sometimes within an involucre ; perianth inferior, with various glandular or petaloid, scaly, internal appendages, sometimes wanting ; stamens definite or 00, distinct or monadelphous ; anthers 2-celled ; ovary sessile or stalked, 1-2-3, or many-celled ; ovules definite, suspended, anatropal ; styles equal to the cells, distinct or combined ; stigma compound, or single with several lobes ; fruit usually tricoccous ; radicle superior. A very extensive family, especially abundant in equinoctial America, but occurring also in India and Africa, North America, and Europe. Among the products are euphorbium, manchineel, cascarilla, castor and croton oils, tapioca, cassava, bottle India-rubber, gum-lac, boxwood, African teak, turnsole, &c. (*Euphorbiaceæ*, Juss.)

VII. ORDER.—Urticals (Urticales).

Flowers scattered, monochlamydeous ; carpels single, superior ; embryo large, in a small quantity of albumen.

1. Family.—*Planes* (Platanaceæ). Trees or shrubs ; leaves alternate, stipules sheathing, scarious, deciduous ; flowers in globose catkins, naked, the sexes in distinct catkins ; stamen one, with scales ; anthers 2-celled ; ovary 1-celled ;

ovules solitary or in pairs, orthotropal; style subulate; fruit of compressed clavate nuts, terminated by a recurved style; radicle inferior; plumule minute. Inhabit Barbary, the Levant, and North America.

2. Family.—*Bread-fruit trees* (Artocarpaceæ). Trees or shrubs; lactescent; leaves alternate, stipules large, deciduous; flowers in dense heads; *male flowers*, perianth 2–4-parted, or 0; *female flowers* variously arranged over a fleshy receptacle, perianth tubular; stamens opposite, and equal to divisions of perianth; anthers 2-celled; ovary 1-celled; ovule erect and orthotropal, amphitropal and parietal, or pendulous and anatropal; style lateral or terminal, often bifid; stigma sometimes radiating; fruit variable, surrounded by a fleshy involucre, or composed of consolidated fleshy calyces, containing numerous nuts; albumen abundant or scanty; radicle superior. Tropical plants in both hemispheres. Among the members are the bread-fruit tree, the cow-tree of Demerara, and the upas-tree *Antiaris toxicaria*.

3. Family.—*Mulberries* (Moraceæ). Trees or shrubs; lactescent; leaves often rough; stipules large, often rolled up; flowers inconspicuous, in heads, spikes, or catkins; *male flowers*, perianth 3–4-parted, or 0; *female flowers*, perianth 3- 4- 5-divided, often in two rows; stamens 3–4, opposite; anthers 2-celled;

ovary 1-celled; ovules solitary, pendulous or amphitropal; style terminal, bifid; fruit a sorosis or syconus; embryo hooked, albuminous; radicle superior. Natives of temperate and tropical climes in both hemispheres. Comprise the fig, banyan, common and white mulberry; and among their products are contrayerva-root, fustic, and caoutchouc, which latter is abundantly supplied by the *Ficus elastica*. (*Sycoideæ*, Link.)

4. FAMILY.—*Hemp-worts* (Cannabinaceæ). Herbaceous; juice watery; leaves alternate, stipulate; flowers inconspicuous; *male flowers* in racemes or panicles; perianth herbaceous, imbricated; *female flowers* in spikes or cones; perianth single, enwrapping the ovary; stamens few, opposite; anthers 2-celled; ovary 1-celled; ovule solitary, pendulous, campylotropal; stigmas two, subulate, sessile; fruit indehiscent; embryo hooked, exalbuminous; radicle superior. Occur in northern temperate regions in the eastern hemisphere. Afford hops, hemp, &c. *Cannabis Indica*, now much used medicinally, yields various narcotic products, known as haschisch, bhang, gunjah, churrus, &c.

5. FAMILY.—*Horn-worts* (Ceratophyllaceæ). Herbs, submersed; leaves dichotomous, verticillate; flowers monœcious; perianth 10–16-parted; stamens 12–20; anthers 2-celled; ovary 1-celled; ovule pendulous, orthotropal; style

filiform; stigma simple; fruit a 1-celled indehiscent nut, terminated by the hardened style; embryo exalbuminous; plumule large, many-leaved; radicle inferior. Live in ditches in Europe, North America, Northern Asia, India, Barbary, and Senegal.

6. FAMILY.—*Elms* (Ulmaceæ). Trees or shrubs; juice watery; leaves alternate, stipulate; flowers in loose clusters, frequently unisexual; perianth inferior, membranous, imbricated, irregular; stamens definite; filaments erect in æstivation; ovary superior or 2-celled; ovules pendulous, anatropal, or amphitropal; stigmas two; fruit 1–2-celled, membranous or drupaceous; albumen scanty or 0; cotyledons foliaceous; radicle superior. Inhabit northern and mountainous parts of Europe, Asia, and America. The principal genus is that of the elms.

7. FAMILY.—*Nettles* (Urticaceæ). Trees, shrubs, or herbs; juice watery; leaves alternate, stipulate, rough, often with stinging hairs; flowers herbaceous, inconspicuous, scattered, or clustered, or in catkins, or close heads; perianth membranous, lobed; stamens definite, distinct, opposite; filaments elastic, curved in æstivation; ovary simple; ovule solitary, erect; stigma simple; fruit an indehiscent nut; embryo straight, albuminous; radicle superior. Widely distributed, many following in the footsteps of man. Remark-

able for the extreme causticity of their juice

8. **Family.**—*Antidesmads* (Stilaginaceæ). Trees or shrubs; leaves alternate, stipulate; flowers minute, in axillary, scaly spikes; perianth 2- 3- 5-partite; stamens two or more, arising from a swollen receptacle; filaments capillary; anthers 2-lobed, cells vertical, opening transversely; ovary 1–2-celled; ovules two, pendulous, anatropal; stigma sessile, 3–5-toothed; fruit drupaceous; embryo straight, albuminous; radicle superior. Natives of the East Indies and of Madagascar.

VIII. ORDER.—AMENTALS (Amentales).

Flowers in catkins, achlamydeous or monochlamydeous; carpels superior; embryo small; albumen little or none.

1. **Family.** — *Oleasters* (Elæagnaceæ). Trees or shrubs; leaves alternate or opposite, exstipulate; flowers axillary, in catkins or panicles, rarely bisexual; *male flowers* amentaceous, with 2–4 leaves forming the perianth; stamens 3- 4- 8; anthers introrse; *female and hermaphrodite flowers*, perianth tubular; ovary 1-celled; ovule solitary, ascending, anatropal; style short; stigma subulate, glandular; fruit a crustaceous achænium, enclosed within the enlarged succulent perianth; radicle inferior. Occur throughout the entire northern hemisphere.

2. FAMILY.—*Bog-myrtles* (Myricaceæ). Leafy shrubs or small trees, covered with resinous glands and dots; leaves alternate, with or without stipules; flowers amentaceous, achlamydeous; stamens 2–8, in the axil of a scale; anthers 2–4-celled; ovary 1-celled; ovule solitary, erect, orthotropal; stigmas two, subulate or petaloid; fruit drupaceous, often with a waxy secretion; seed solitary, erect; radicle superior; inhabit temperate and tropical regions in North and South America, and India, and at the Cape of Good Hope; one species is European.

3. FAMILY.—*Willows* (Salicaceæ). Trees or shrubs; leaves alternate, stipulate; flowers amentaceous, naked, or with a membranous cup-shaped perianth; stamens distinct or monadelphous; anthers 2-celled; ovary 1-celled; ovules 00, erect, anatropal; style 1 or 0; stigmas 2–4; fruit coriaceous, 1-celled, 2-valved; seeds 00, comose; embryo erect; radicle inferior. Inhabit temperate and arctic regions. Comprise the Willow, the Sallow, and the Poplar.

4. FAMILY.—*Altingiads* (Liquidambaraceæ). Tall trees, balsamic; leaves alternate, stipulate; flowers with verticillate bracts or minute scales; female catkins on longer stalks than the males; anthers numerous; ovary 2-celled; ovules 00, amphitropal; styles two; fruit of 2-celled capsules, united into a hard cone;

seeds numerous, winged; radicle superior. Yield Liquid-Storax. (*Altingiaceæ*, Lindl.)

5. Family.—*Birches* (Betulaceæ). Trees or shrubs; leaves alternate, stipulate; flowers amentaceous, with bracts, which are at times verticillate; stamens distinct, opposite; anthers 2-celled; ovary 2-celled; ovule solitary, pendulous, anatropal; style single or 0; stigmas two; fruit membranous, indehiscent, forming a kind of cone; seeds pendulous; albumen none; radicle superior. Natives of temperate, arctic, and antarctic regions. Comprehend the species of Birch and of Alder.
6. Family. — *Beefwoods* (Casuarinaceæ). Trees, branching, weeping; leaves 0, replaced by membranous, toothed sheaths; flowers bracteate; *male flowers* in spikes, *female flowers* in dense heads; stamen one; anther 2-celled; ovary 1-celled; ovules one, obliquely-ascending, or two side by side; styles two; fruit of winged achænia, collected into a cone; seed erect; radicle superior. Natives of Australasia.

GYMNOGENS.

Gymnogens, called also Gymnosperms, constitute a small Class, in many respects closely allied to the one last under consideration. Their seeds have two cotyledons, and their stems are Exogenous, but they are distinguished by the vessels of the wood having large apparent perforations. Their chief peculiarity, however, consists in the naked, uncovered condition of the seed, and in the fertilization of their female organs taking place through the foramen of the ovule, without the aid of either style or stigma. In general appearance they bear a strong resemblance to some flowerless groups, as the Club-mosses and Ferns, so much so as to have been, by Linnæus and others, classed with the latter. They contain the curious Joint-Firs, the melancholy Yews, the invaluable Pines, and the feathery Cycads, comprising in all, thirty-seven genera, and upwards of two hundred species.

II. CLASS.—GYMNOGENS (Gymnogenæ).

A cellular and a vascular system; stem with wood and true bark; vessels of wood with large apparent perforations; wood in concentric zones, augmented by growth from without; embryo dicotyledonous; ovules fertilized by direct contact, without the intervention of style or stigma; germination exorhizal.

1. FAMILY.—*Joint-Firs* (Gnetaceæ). Small trees very much branched, or sarmentose shrubs; juice watery; stems jointed; leaves opposite, simple, net-veined; flowers in catkins or heads; *male flowers* with a perianth; *female flowers* naked, or sheltered by a false perianth; anthers 1–4-celled, opening by pores;

ovary 0; ovule with a style-like process formed from the inner covering of the nucleus; seed drupaceous; embryo with a long, spirally twisted funiculus. Inhabit temperate parts of Europe, Asia, and South America.

2. FAMILY.—*Yews* (Taxaceæ). Trees or shrubs; branches unarticulated; stems continuous; leaves alternate or distichous, evergreen, rigid, veinless or fork-veined; flowers naked, but surrounded by imbricated bracts; stamens several; filaments monadelphous; anthers 2-celled, dehiscence longitudinal; ovules naked, the outer skin becoming finally hard; fruit somewhat drupaceous; embryo straight. Common in mild climates generally, especially in Asia, also in elevated tropical districts; often resinous.

3. FAMILY.—*Pines* (Pinaceæ). Trees or shrubs, evergreen; resinous; trunk continuous, branched; leaves simple, acerose or lanceolate; flowers naked, *male flowers* monandrous or monadelphous; *female flowers* in cones; anthers 2- or many-lobed, dehiscence longitudinal; ovary spread open, resembling a flat scale without style or stigma; ovules naked, in pairs or several; fruit of cones composed of hardened, scale-shaped ovaries; embryo albuminous. Widely dispersed, but abound more in temperate climes. Among the members are the Fir, Pine, Larch, Cedar,

Cypress, and Juniper. Among the products are Turpentine, Tar, Burgundy-Pitch, Hungarian Carpathian and Canada Balsams, Essence of Spruce, Sandarach, Savin, &c. (*Coniferæ*, Juss.)

4. FAMILY.—*Cycads* (Cycadaceæ). Trees or shrubs; trunks cylindrical, sometimes dichotomous; leaves pinnate, parellel-veined, vernation circinnate; flowers unisexual; *male flowers* in terminal cones, the scales bearing on their lower sides 1-celled anthers; *female flowers* consisting of naked ovules at the base of flat scales, beneath peltate ones, or on the margins of altered leaves; seeds hard, nut-like; embryos 1–2, suspended; albumen fleshy or mealy; cotyledons unequal. Occur in temperate and tropical parts of Asia and America, also at the Cape of Good Hope, and in Madagascar. Yield much starchy matter.

DICTYOGENS.

On examining the structure of some anomalous Monocotyledons, they were ascertained by Lindley to possess, in nearly equal proportions, characters of Endogens and of Exogens. He therefore separated them from the Endogens, with which they had been previously united, and established them as a transition class, which he named "Dictyogens," on account of the reticulated appearance of the leaves.

The wood of the stem is Endogenous, the youngest parts being in the centre, while, on the other hand, the root exhibits concentric zones like an Exogen, with a disposition to a radiated distribution of vessels, and in some with a central pith; the leaves, also, are net-veined, and usually disarticulate with the stem. Dictyogens are far from numerous, about seventeen genera being at present enumerated, containing upwards of two-hundred-and-sixty species. They may be divided into two Sub-classes, according to the unisexual or bisexual nature of the flower, the two being united by the *Smilaceæ*, which contain both forms of structure. Some of the families are small, and imperfectly known, but two are of considerable consequence, the one affording the Yam, an important farinaceous article of diet in the Tropics, and the other yielding the Sarsaparilla plants, largely imported into England for medical use.

III. CLASS.—DICTYOGENS (Dictyogenæ).

Growth of stem endogenous; root with the wood arranged in solid concentric circles; foliage broad, net-veined, deciduous; cotyledon single.

I. *SUB-CLASS*—BISEXUAL-DICTYOGENS (Monanthiæ).

Flowers perfect, each bearing male and female organs.

1. FAMILY. — *Roxburgh-worts* (Roxburghiaceæ).
Shrubs, twining; roots tuberous; leaves coriaceous; flowers large, showy, solitary,

fœtid; perianth with four petaloid divisions; stamens four, hypogynous; anthers adnate; ovary superior, 1-celled; placentæ basal; style none; ovules 00, anatropal; pericarp 1-celled, 2-valved, with two clusters of seeds at the base; embryo taper, albuminous. Natives of hot parts of India.

2. FAMILY.—*Trilliads* (Trilliaceæ). Herbaceous, simple-stemmed; leaves verticillate, membranous; flowers large, terminal, solitary; perianth 6–8-divided, coloured or herbaceous; stamens 6–10; anthers linear; ovary free, 3–5-celled; styles 3–5, distinct; ovules 00, anatropal; fruit succulent, 3–5-celled; seeds 00; embryo minute, albuminous. Inhabit temperate parts of Asia, Europe, and North America. (*Parisidæ*, Burnett.)

3. FAMILY. — *Philesiads* (Philesiaceæ). Shrubs, twining or upright; leaves coriaceous; flowers large, showy, solitary, 3–6-petaloideous; stamens six; anthers linear; ovary free, 1-celled; placentæ parietal; style long, club-shaped; stigmas three; ovules 00, orthotropal; fruit succulent. Natives of Chili.

4. FAMILY.—*Sarsaparillas* (Smilaceæ). Herbs or under-shrubs, often climbing; stems scarcely woody; flowers bisexual or polygamous; perianth petaloid, 6-partite; stamens six, rarely hypogynous; ovary 3-celled, cells uni- or multi-ovulate; ovules orthotropal; style

usually trifid; stigmas three; fruit a globular berry; embryo very small, albuminous. Occur chiefly in temperate and tropical parts of Asia and America. This family yields the different kinds of Sarsaparilla, many of which are much employed in medical practice; though possessed of valuable properties in their native places, they seem to be much impaired by exportation, and in Europe to have but feeble actions.

II. *SUB-CLASS.*—UNISEXUAL-DICTYOGENS (Dianthiæ).

Male and female organs on separate flowers.

1. FAMILY.—*Yams* (Dioscoreaceæ). Shrubs, twining, tuberous; leaves mostly alternate; flowers small, spiked, bracteated; perianth 6-divided, adherent; stamens six; anthers introrse; ovary adherent, 3-celled; ovules anatropal; style 2–3-fid; stigmas undivided; fruit capsular, compressed, trilocular; seeds winged or wingless; embryo small, albuminous. Mostly inhabitants of tropical countries. Chiefly valuable as affording yams, the tropical substitute for the potato: in Europe, this family is represented by the Black Bryony (*Tamus communis*).
2. FAMILY.—*Tail-worts* (Triuridaceæ). Herbs, perennial; rhizome creeping; leaves solitary; flowers regular, with 1-flowered, bracteate stalks; perianth free, corolline, 3–6-partite, permanent; stamens 3-6 (?); anthers ex-

trorse ; ovaries 0 0, sessile ; ovules solitary (?); styles subulate, or thickened at the apex. Found in Brazilian woods.

ENDOGENS.

What is commonly known as the endogenous type of structure characterizes a large assemblage of flowering-plants, forming the class we are now to consider. In importance and extent it approaches the Exogens, and its geographical distribution is quite as varied and general. The most obvious distinctive mark of this division is found in the structure of the stem, new matter being developed in the interior, though, taken in a wide sense, this does not strictly apply. If a cross section be made of an endogenous stem, it will present an irregular, dotted surface, the dots being more numerous towards the circumference, where the wood is also hardest: if cut again vertically, numerous strings or bundles of woody fibres will be seen apparently springing from the centre, and proceeding in a curved direction towards the circumference. But the more accurate researches of Schleiden shew that all plants possessing a stem are, to a certain extent, endogenous, and that the true and essential distinction between the monocotyledonous and dicotyledonous classes, consists in the mode and degree of development of the woody or fibro-vascular bundles. In the latter, their growth is unlimited, terminating only with the death of the individual, while among the former it is limited, being arrested at a definite period by a cessation of generative power in the woody cells. Endogens are destitute of true pith, and their stems are seldom hollow, exceptional cases—such as in many of the grasses, being caused by the circumference growing more rapidly than the centre. The leaves are not reticulated, as among exogens, but are straight-veined, and the parts of the flower are usually arranged in series of threes; the embryo, too, is composed of but one cotyledon, whence they were, by De Candolle, termed *monocotyledones*. Their period of vitality, also, is more restricted than it is in the higher class, seldom extending beyond two or three hundred years, though occasional instances of more extended longevity occur, as in a dragon-tree, still existing at Teneriffe, which, more than 450 years ago, was regarded as very aged.

The number of genera known at present is upwards of 1,400, which include about 13,600 species. Among these are numerous plants of the greatest importance to man, as various members of the family of grasses, some yielding him abundant farinaceous aliment, while others afford nutriment for his flocks and his herds. The palms supply wine, sugar, edible fruits, and sago; arrow-root is the produce of species of *Maranta;* the aromatic root of the *Zingiber* constitutes ginger; while turmeric, obtained from *Curcuma longa,* forms a valuable dye, and is the basis of some admired condiments. The number of hurtful species is comparatively few, these being principally found among the *Melanthiaceæ*, and some of the *Araceæ*.

IV. CLASS.—ENDOGENS (Endogenæ).

Wood of stem and of root, arranged in a confused manner, the youngest in the centre; leaves straight-veined, permanent; organs of fructification ternary; embryo monocotyledonous; germination endorhizal.

I. *SUB-CLASS.*—Bisexual-Endogens (Diphyseæ).

Flowers hermaphrodite; perianth present.

I. TRIBE.—Hypogynous-Endogens (Phylleleutheræ).

Flowers free from the ovary, rarely perigynous.

I. ORDER.—Alismals (Alismales).

Perianth 3-6-divided; carpels separate; albumen none.

1. Family. — *Arrow-grasses* (Juncaginaceæ). Herbaceous; leaves parallel-veined; flowers inconspicuous, scaly, white or green, in spikes or racemes; sometimes perianth 0; stamens six; anthers extrorse; carpels 3-4-6; ovules 1-2; placentæ axile or basal; fruit dry, 1-2-seeded; embryo slit on one side; plumule very large. Marshy and aquatic plants, in most parts of the world.
2. Family. — *Water-plantains* (Alismaceæ). Herbaceous; leaves narrow or expanded; flowers in umbels, racemes, or panicles, very rarely

unisexual; perianth 6-divided, in two whorls, inner whorl petaloid; stamens definite or 00; anthers introrse; ovaries several; ovules solitary or in pairs; placentæ axile or basal; fruit dry, 1-2-seeded; embryo curved or hooked. Floating or marsh plants, chiefly in northern temperate regions.

3. FAMILY.—*Flowering-rushes* (Butomaceæ). Herbaceous; often lactescent; leaves very cellular; flowers umbellate or solitary, conspicuous; perianth 6-divided, in two whorls, the outer herbaceous, the inner petaloid; stamens definite or 00; ovaries 3–6, or more, united or distinct; ovules 00, anatropal or campylotropal; placentæ many-seeded, netted, and parietal; fruit of several follicles, distinct and beaked, or united; embryo often curved. Aquatic and swamp plants, mostly northern.

II. ORDER.—LILIALS (Liliales).

Perianth 6-divided; albumen copious.

1. FAMILY. *Pontederiads* (Pontederiaceæ). Herbaceous; leaves sheathing, sometimes cordate or sagittate; flowers solitary, or in spikes or umbels, spathaceous; perianth tubular, coloured, circinnate when withering; stamens 3-6; anthers introrse; ovary free, 3-celled; ovules numerous, anatropal; fruit capsular, 3-celled, 3-valved; seeds 00; embryo straight; albumen mealy. Aquatic species, inhabiting

North and South America, India, and tropical Africa.

2. Family.—*Lilies* (Liliaceæ). Herbs, shrubs, or trees; bulbous, tuberous, rhizomatous, or fibrous-rooted; leaves rarely expanded; flowers various, from large and showy to small and green; perianth 6-divided, in two verticils, coloured, flat when withering; stamens six; anthers introrse; ovary free, 3-celled; ovules 00, anatropal or amphitropal; fruit succulent, or dry and capsular, 3-celled; albumen fleshy. Distribution extended, but more abundant in temperate climates. Contain numerous important plants, and yield a variety of valuable products; among the former are New Zealand flax (*Phormium*), African hemp (*Sanseviera*), onion, garlic, leek, eschallot, chives, asparagus, lily, tulip, hyacinth, &c.; and among the latter, true Dragon's-blood from *Dracæna Draco*, and Botany Bay gum from species of *Xanthorrhœa.* It also affords some active drugs, as aloes, the inspissated juice of various species of *Aloë*, and squills, the bulb of *Squilla maritima.*

3. Family. — *Meadow-saffrons* (Melanthiaceæ). Herbs; bulbous, tuberous, or fibrous-rooted; leaves sheathing; flowers sometimes polygamous; perianth 6-divided, petaloid, flat when withering; stamens six; anthers extrorse; ovary 3-celled; ovules numerous;

style 3-parted; fruit capsular, 3-celled; albumen dense, fleshy. Distribution extensive, more abundant in northern temperate countries. A poisonous family, yielding colchicum, white hellebore (*Veratrum*), and sabadilla.

4. FAMILY. — *Gilliesiads* (Gilliesiaceæ). Herbs; bulbs tunicated; leaves grass-like; flowers umbellate, spathaceous; perianth 6-partite, in two rows, the outer herbaceous and petaloid, the inner smaller and more coloured; stamens in two whorls, the outer sterile, scale-like, or forming an urceolate, 6-toothed body; the inner of six stamens, being occasionally sterile; ovary 3-celled; style one; fruit capsular, 3-celled, 3-valved; embryo curved; albumen fleshy. Small Chilian plants.

III. ORDER.—JUNCALS (Juncales).

Flowers scaly or scarious; albumen abundant.

1. FAMILY.—*Sweet-flags* (Orontiaceæ). Herbaceous; occasionally stemless, or aquatic; flowers on a spathaceous spadix; perianth scaly, or 0; stamens 4-5-6-8; anthers 2-celled; ovary 1- or more celled; ovules erect or pendulous; stigma sessile, or on a subulate style; fruit a berry; embryo axile, with a lateral cleft. Natives of tropical and temperate countries. The rhizomes of *Calla palustris* are used as food in Lapland; Sweet-flag (*Acorus calamus*) is employed in medicine.

2. FAMILY. — *Rushes* (Juncaceæ). Herbs; roots fascicled or fibrous; leaves fistular, grooved, or flat; inflorescence often capitate; flowers umbellate, racemose, spiked or panicled; perianth 6-parted, glumaceous or cartilaginous; stamens 3-6; anthers introrse, 2-celled; ovary 1-3-celled; ovules 1-3, or many in each cell; style one; stigmas 1-3; fruit capsular, 3-valved; embryo minute, undivided. Inhabit principally colder climes, reaching as far north as Melville Island. Employed extensively in the manufacture of mats, chair-bottoms, candles, &c.

IV. ORDER.—XYRIDALS (Xyridales).

Perianth mostly 6-divided, the inner whorl petaloidal; albumen abundant.

1. FAMILY. — *Mayacs* (Mayacaceæ). Herbaceous, moss-like; leaves very narrow, pellucid; flowers small; perianth 6-divided, the outer whorl herbaceous, short; stamens three; anthers 1-celled; ovary of three carpels; style filiform; placentæ parietal; ovules sessile; fruit capsular, membranous, 1-celled, 3-valved; embryo very minute, on the outside of fleshy albumen. Natives of American marshes.

2. FAMILY.—*Spider-worts* (Commelynaceæ). Herbs; leaves flat, narrow, usually sheathing; perianth in two whorls, the outer 3-partite, herbaceous, the inner 3-partite or 3-fid; stamens 3-6;

anthers 2-celled, introrse; ovary 3-celled; ovules few in each cell; style and stigma one; fruit capsular, 2-3-celled, 2-3-valved; embryo pulley-shaped, half-immersed in fleshy albumen. Occur in the East and West Indies, Australia, Africa, and also in North America.

3. FAMILY.—*Xyrids* (Xyridaceæ). Herbs, sedge-like; fibrous-rooted; leaves radical, sheathing, flowers in terminal, imbricated, scaly heads; perianth 6-partite, in two whorls, the outer one glumaceous; stamens six, 3-fertile; anthers 2-celled, extrorse; ovary single, 1-celled; ovules 0 0; placentæ parietal; style 3-fid; fruit capsular, 1-celled, 3-valved; embryo minute, on the outside of fleshy albumen. Natives of tropical Asia, Africa, and America.

4. FAMILY.—*Water-worts* (Philydraceæ). Herbs; root fascicled-fibrous; stems often woolly; leaves equitant, partly-sheathing; inflorescence in terminal spikes; flowers alternate, solitary, sessile, with a spathaceous, persistent bract; perianth with the outer whorl abortive, inner 2-divided, petaloid; filaments three, united at the base; two lateral stamens petaloid and abortive; ovary superior; ovules 0 0; placentæ parietal or axile; fruit capsular, 3-celled, 3-valved; embryo axile, in fleshy albumen. Found in China, Cochin-China, and Australia.

II. TRIBE.—Epigynous-Endogens (Phyllosynaptæ).

Flowers adherent to the ovary.

I. ORDER.—Orchidals (Orchidales).

Stamens 1-3; albumen none.

1. Family.—*Apostasiads* (Apostasiaceæ). Herbs, perennial; leaves firm, thin, sheathing; flowers racemose, terminal; perianth 6-divided; anthers 2-3, sessile on a short column, erect, 2-celled; style filiform, with a 3-lobed stigma as long as the anthers, and adherent with the filaments into a short column: ovary 3-celled; placentæ three, axile, polyspermous; fruit capsular, 3-celled, 3-valved; seeds 0 0. Occur in damp, hot Indian woods.
2. Family.—*Orchids* (Orchidaceæ). Herbs or shrubs; roots fibrous or tubercular; stem long and annual, perennial and woody, or none; leaves often sheathing; flowers solitary, clustered, spiked, racemose, or panicled, always supported by a solitary bract; perianth herbaceous or coloured, membranous or fleshy, 6-partite, the segments arranged in two rows, the outer, or calycine (but according to Lindley the corolla), of three parts; the inner, or corrolliform (petaloid stamens of Lindley), of three divisions, rarely one, the odd one being the *labellum* or lip; stamens three, the lateral ones usually sterile; anthers 1-2-4-celled; ovary 1-celled, of six carpels, three

only bearing placentæ; style incorporated with the column; fruit capsular, rarely fleshy, 3-6-valved, indehiscent; seeds 00. Distribution universal, except in the frozen zones, and in extremely dry regions. Chiefly terrestial, but numerous tropical species are epiphytic. The *Orchidaceæ* comprise nearly 400 genera, and about 3000 species.

3. Family.—*Burmanniads* (Burmanniaceæ). Herbs; leaves radical or none; inflorescence terminal; perianth coloured, tubular, 6-cleft, the three inner being minute, and the three outer larger and often keeled at the back; stamens three; anthers sessile, 2-celled; ovary 1-3-celled; ovules 00; style simple; stigmas three; fruit capsular, 1-3-celled, 3-valved, crowned by the persistent perianth; seeds 00. Occur in moist grassy spots in tropical countries.

II. ORDER.—Amomals (Amomales).

Flowers unsymmetrical; stamens 1-6, some being abortive; seeds albuminous.

1. Family.—*Arrow-roots* (Marantaceæ). Herbaceous, without aroma; rhizomes frequently tuberous; leaves simple, sheathing; inflorescence spiked, racemose, or panicled, terminal or radical; perianth in two whorls, the outer 3-lobed, short, inner 3-partite, elongated; stamens in two verticils, the outer 3-fid, petaloid, sterile, the inner three, petaloid,

one lateral being fertile; anther on the margin of the filament; ovary 1-3-celled; ovules solitary or numerous; style petaloid or swollen; stigma either the naked apex of the style, or hollow, hooded, and incurved; fruit capsular, 3-celled, or baccate and 1-celled; embryo without a vitellus. Found in tropical America and Africa, and in India. The rhizomes abound in starch, occuring as "Arrowroot" in species of *Maranta,* and as "Tous-les-mois" in *Canna.* (*Cannaceæ,* Agardh.)

2. FAMILY.—*Gingers* (Zingiberaceæ). Herbaceous; aromatic; rhizome creeping; leaves simple, sheathing; inflorescence and flowers as in *Marantaceæ;* stamens in two whorls, the outer 3-partite, sterile, petaloid, the inner of three, the central one being fertile; anther 2-celled; ovary 3-celled; ovules several; style filiform; stigma dilated, hollow; fruit capsular, 3-celled, occasionally berried; embryo with a vitellus. Chiefly tropical plants. Afford Ginger (*Zingiber*), Cardamoms, from species of *Amomum, Elettaria,* and *Renealmia,* and Turmeric from *Curcuma longa.* (*Drymyrhizeæ,* Vent. *Scitamineæ,* R. Brown.)

3. FAMILY.—*Bananas* (Musaceæ). Herbs; stemless or nearly so, with spurious stems of sheathing leaf-stalks, from subterranean root-stocks; flowers spathaceous; perianth 6-cleft, petaloid, in two whorls; stamens six, some always abortive; anthers linear, 2-celled,

introrse; ovary 3-celled; ovules numerous; style single; stigma usually 3-lobed; fruit capsular, 3-celled, or succulent and indehiscent. Natives of warm and tropical countries. Species of *Musa* yield the Banana and Plantain.

III. ORDER.—Narcissals (Narcissales).

Flowers symmetrical; stamens 3-6; seeds albuminous.

1. Family.—*Flags* (Iridaceæ). Herbs, rarely undershrubs; roots tuberous or fibrous; leaves mostly equitant or distichous; inflorescence terminal, in spikes, corymbs, or panicles; bracts spathaceous; perianth 6-parted, coloured, in two whorls; stamens three; anthers extrorse, 2-celled; ovary 3-celled; ovules numerous; style one; stigmas three, often petaloid or bilabiate; fruit capsular, 3-celled, 3-valved; seeds numerous. Found in warm and temperate regions, especially abundant at the Cape of Good Hope. Yield Saffron and Orris-root.
2. Family. — *Daffodils* (Narcissaceæ). Herbs or shrubs; bulbous or fibrous-rooted; stem at times woody and tall; leaves ensiform; flowers spathaceous; perianth regular, 6-cleft; stamens six, sometimes partially coherent; sometimes with additional sterile stamens; anthers introrse; ovary 3-celled; ovules 00; style one; stigma 3-lobed; fruit capsular,

3-celled, and 3-valved, or baccate and 1-3-seeded. Principally Cape species, but occur also in Europe, the East and West Indies, South America, and Australia. Some possess poisonous qualities. Yield many garden-flowers, as the Narcissus, Daffodil, Snowdrop; the Agave or American Aloe, is also a member. (*Amaryllideæ*, R. Brown.)

3. FAMILY. — *Hypoxids* (Hypoxidaceæ). Herbs; tuberous or fibrous-rooted; leaves radical, plicate; scapes simple or branched; perianth petaloid, usually 6-partite; stamens six; anthers introrse, 2-celled; ovary 3-celled; ovules 00; style simple; stigma 3-lobed; fruit indehiscent, dry or berried, 1- 2- 3-celled. Natives of tropical and warm countries.

4. FAMILY. — *Blood-roots* (Hæmodoraceæ). Herbs, fibrous-rooted; leaves equitant, distichous; perianth 6-cleft, petaloid, tubular, more or less woolly; stamens three or six; anthers introrse; ovary 1-3-celled; ovules one, two, or many; style simple; stigma undivided; fruit capsular, 3-valved or indehiscent; radicle remote from the hilum, which is naked. Occur in North and South America, at the Cape of Good Hope, and in Australia. Named from the red colour of the roots.

5. FAMILY.—*Taccads* (Taccaceæ). Herbs, tuberous; leaves radical, stalked; flowers on the top of a simple taper or angular furrowed scape, umbellate, involucrate; perianth with a cy-

lindrical ribbed tube; stamens six; filaments petaloid; anthers 2-celled; ovary of three connate carpels; placentæ three, parietal, polyspermous; styles three, connate; stigmas 2-lobed; fruit baccate, indehiscent; albumen fleshy. Inhabit woods, and damp maritime spots in tropical Africa, India, and Polynesia.

6. FAMILY.—*Pine-apples* (Bromeliaceæ). Herbs or shrubs; stemless or short-stemmed, often epiphytic; leaves rigid, channeled, often spiny-edged; flowers racemose or panicled; perianth 6-divided, in two whorls, outer persistent, inner petaloid, marcescent or deciduous, æstivation imbricate; stamens six; anthers introrse; ovary 3-celled; ovules 00; style simple; stigma 3-lobed, or entire; fruit capsular or succulent, 3-celled; albumen fleshy. All American species. The most important product is the Pine-apple or Ananas, yielded by *Ananassa sativa.*

II. *SUB-CLASS.*—UNISEXUAL-ENDOGENS (Monaphyseæ).

Flowers unisexual; with or without perianth.

I. ORDER.—HYDRALS (Hydrales).

Flowers perfect or imperfect, not arranged on a spadix; albumen none; aquatic.

1. FAMILY.—*Sea-wracks* (Zosteraceæ). Sea-weed like; leaves grassy, thin, sheathing; flowers very minute, naked, or surrounded by three scales; stamens hypogynous; anthers de-

finite, sessile, 1-2-celled; pollen confervoid; ovary free, 1-celled; ovule solitary; stigmas 1-2; fruit drupaceous, 1-seeded; seed pendulous. Marine plants, inhabiting the bottom of the ocean, principally in Northern parts of the Eastern Hemisphere.

2. Family.—*Pond-weeds* (Naiadaceæ). Leaves very cellular, stipulate; flowers inconspicuous, often in terminal spikes; perianth of 2-4-pieces, deciduous, sometimes 0; stamens definite, hypogynous; pollen globose; ovaries one or more, superior; ovule solitary; stigma simple; fruit dry, 1-celled, 1-seeded; seed erect or pendulous. Natives of extra-tropical countries in fresh-water, or on the sea-shores. (*Potameæ*, Juss.)

3. Family.—*Frog-bits* (Hydrocharidaceæ). Herbs; leaves sometimes spiny; flowers spathaceous, occasionally bisexual; perianth with a 6-partite limb, the outer herbaceous, the inner petaloid; stamens definite or indefinite, epigynous; ovary adherent, 1- or many-celled; stigmas 3-6; ovules 00; fruit dry or succulent, indehiscent, 1- or many-celled. Fresh-water plants, inhabiting Europe, North America, and India.

II. ORDER.—Palmals (Palmales).

Flowers perfect, on a branched, scaly spadix; embryo minute, placed beneath the surface of horny or fleshy albumen; unisexual or bisexual.

I. *SUB-ORDER.*—ATELESPATHEOUS-PALMS (Atelespatheæ).

Spathes numerous and incomplete.

1. FAMILY.—*Sago-Palms* (Lepidocaryaceæ). Trees; leaves pinnate or fan-shaped; inflorescence in amentiform racemes; perianth 6-divided; stamens six, rarely 0 0, hypogynous or perigynous; pistil usually of three carpels, becoming connate, usually 3-locular; ovules generally solitary, erect; fruit baccate, loricate, scales horny, spirally or verticillately arranged, imbricated. To this family belong the Reed-Palms (*Calamus*), affording Rattans, and the *Sagus farinifera*, supplying Sago. (*Calaminæ*, Griff.)
2. FAMILY.—*Palmyra-Palms* (Borassaceæ). Trees; leaves pinnate or flabelliform; inflorescence in amentiform racemes; stamens hypogynous; pistil usually of three connate carpels, which are 3-locular; ovules solitary, ascending or horizontal; fruit drupaceous and undivided, lobed and 3-seeded, or baccate and, by abortion, 1-seeded. Among the species are the Doum-palm of Upper Egypt (*Hyphæne coriacea*), the Fan-palm, *Borassus flabelliformis*, yielding a copious vinous sap, and *Lodoicea Seychellarum*, or the double Coco-nut tree.
3. FAMILY. — *Date-Palms* (Coryphaceæ). Trees; leaves clustered, terminal; inflorescence not in amentiform racemes; stamens hypogynous or perigynous, 6-9-12; pistil of three

distinct carpels, becoming sometimes connate; ovules solitary, erect, lateral or horizontal; fruit baccate or drupaceous, threefold, deeply lobed, or, by abortion, double or single. Among the members of this division are the Ceylon Talipot-palm (*Corypha umbraculifera*), and the Date-palm (*Phœnix dactylifera*).

II. *SUB-ORDER.*—TELESPATHEOUS-PALMS (Telespatheæ).

Spathes occasionally absent, always complete when present.

4. FAMILY.—*Betel-nut Palms* (Arecaceæ). Trees; spadix scaly; spathe often wanting; stamens hypogynous; ovary mostly of three connate carpels, which are tri-locular; ovules erect; fruit baccate or semi-drupaceous, tri-locular, or deeply 3-lobed, 1-seeded. Yield the Betel-nut (*Areca Catechu*), which also supplies Colombo Catechu; the Cabbage-palm of the West Indies is *A. oleracea; Saguerus Rumphii* is one of the sources of the Sago of commerce.

5. FAMILY.—*Oil-yielding Palms* (Cocaceæ). Usually trees; stems sometimes spiny; stamens six or more, hypogynous; filaments sometimes conjoined at their base; pistil of three united carpels, rarely 2- 4- 5- or 6; ovules solitary, erect or horizontal; fruit drupaceous, 1-seeded, generally uni-locular; endocarp thick, osseous, or stony; putamen with its

cells, when fertile, perforated opposite the seat of the embryo, and, when abortive, indicated by cœcal foramina; albumen cartalaginous or amygdaloid, oleaginous. Among these are the *Cocos nucifera*, or Coco-nut palm, species of *Elais* yielding Palm-oil, and *Phytelephas macrocarpa*, the source of Vegetable Ivory.

III. ORDER.—ARALS (Arales).

Petaloidal, or naked-flowered; spadix simple, naked; embryo in the axis of mealy or fleshy albumen.

1. **FAMILY.**—*Screw-pines* (Pandanaceæ). Trees or bushes, often sending down aerial roots; leaves imbricated, amplexicaul, often spiny-edged, or pinnate or fan-shaped; floral leaves smaller; flowers often polygamous, naked or scaly, covering the whole of the spadix; stamens numerous; filaments with single anthers, which are 2-4-celled; ovaries in parcels, 1-celled; ovules solitary or numerous; stigmas sessile; fruit fibrous-drupes collected into parcels, or baccate and many-seeded; seeds loose; embryo minute, solid. Tropical plants.
2. **FAMILY.**—*Arads* (Araceæ). Herbaceous, with a fleshy corm, or shrubs; leaves sheathing; spadix generally spathaceous; flowers naked, on the surface of a spadix; stamens definite

or indefinite, hypogynous; anthers sessile, 1-2- or many-celled, extrorse; ovary free, mostly 1-celled; stigma sessile; fruit succulent; seeds pulpy; embryo slit, axile. Inhabitants principally of hot countries. Many are poisonous; the corms of some abound in amylaceous matter. (*Aroideæ*, Juss.)

3. FAMILY.—*Bulrushes* (Typhaceæ). Herbaceous; stems nodeless; leaves rigid, ensiform; flowers upon a spatheless spadix; perianth scaly or hairy; stamens 3-6; anthers wedge-shaped, on long filaments, which are sometimes monadelphous; ovary superior, 1-celled; ovule solitary; style short; stigma linear; fruit dry, 1-celled, 1-seeded; seed adherent to its pericarp; embryo slit. Occur in ditches and marshes in northern countries.

4. FAMILY.—*Duck-weeds* (Pistiaceæ). Herbaceous; leaves very cellular; flowers 2-3, enclosed in a spathe, without a spadix; stamens definite, often monadelphous; ovary 1-celled; style short; stigma simple; ovules two or more, erect; fruit membranous or capsular; embryo slit. Found in ditches in temperate parts of the world.

III. *SUB-CLASS.*—SCALE-FLOWERED ENDOGENS (Glumaleæ).

Flower glumaceous, *i. e*, consisting of imbricated, colourless herbaceous scales or bracts.

I. ORDER.—Rush-like Glumals (Skoinoideæ).

Pistil simple; ovules pendulous.

1. Family. — *Pipe-worts* (Eriocaulaceæ). Herbaceous; leaves cellular, spongy, sheathing; flowers unisexual, capitate, bracteate, very minute; glumes two, unilateral, or three; stamens 2 - 6; anthers 2-celled; ovary superior, 2 - 3-celled, surrounded by a 2 - 3-dentate or lobed membranous tube; ovules solitary; style very short; stigmas 2 - 3; fruit capsular; seeds pilose; embryo terminal. Abundant in tropical America and Australia, a few occur in North America, and one in Scotland.

2. Family. — *Cord-rushes* (Restiaceæ). Herbs or under-shrubs; leaves narrow or none; culms naked or sheathed; flowers in spikes, usually unisexual; glumes 2 - 6, seldom wanting; stamens 1 - 3; anthers generally 1-celled; ovary 1 - 3-celled, cells monospermous; styles and stigmas two or more; fruit capsular or nucamentous; seeds not pilose; embryo terminal. Inhabit woods and marshes in South America, South Africa, and Australia.

3. Family.—*Bristle-worts* (Centrolepidaceæ). Herbaceous; leaves setaceous, sheathing; scapes filiform, naked; flowers in a spathe; glumes one in front, or two opposite each other; paleæ 0, or one or two tender scales parallel with the glumes; stamens 1 - 2; anther 1-

celled; ovaries 1-18, 1-celled; fruit 1-18, 1-seeded, utricles opening longitudinally. Natives of Polynesia and Australasia. (*Desvauxiaceæ*, Lindley.)

II. ORDER.—PALM-LIKE GLUMALS (Phænikoideæ).

Pistil compound; ovule erect or ascending.

1. FAMILY.—*Sedges* (Cyperaceæ). Herbaceous, grass-like; stems solid, often without joints; leaves narrow, sheaths entire; flowers unisexual or bisexual, generally without a perianth; each flower with a solitary bract; bracts imbricated on a common axis, the lowermost often empty; stamens hypogynous, 1-12; anthers 2-celled; ovary 1-seeded, often surrounded by hypogynous bristles; fruit a crustaceous or bony nut; embryo enclosed within the base of the albumen. Distribution almost universal. The "Papyrus" of the ancients is the product of *Papyrus antiquorum*, which inhabits Syria and Egypt.
2. FAMILY.—*Grasses* (Avenaceæ). Herbaceous, evergreen; stems sometimes of large size, cylindrical, hollow, jointed; leaves narrow, alternate, with a membranous expansion at the junction of the stalk and blade called a "ligule," sheath split; flowers green, occasionally monœcious or polygamous, 1, 2, or more, on a common axis, forming *locustæ*, which are spiked, racemose, or panicled; the outer bracts, usually two, are named

glumes, the next, also two, *paleæ* or *glumellæ*, and the innermost set, consisting of two or three scales, are styled *squamulæ* or *glumellulæ*; stamens 1-6, hypogynous; anthers versatile; ovary 1-celled; styles 2-3, rarely combined; stigmas feathery or hairy; fruit a caryopsis; seed incorporated with the pericarp; embryo lateral, naked; albumen farinaceous. Distribution universal; are very numerous in individuals, and constitute nearly one twenty-second part of known plants; in the tropics they are larger, being often arborescent. Divided into two sub-families, viz.: 1. *Panicinæ*, locusta of two flowers, the lower or outer uniformly imperfect, being either staminiferous or neuter, and then not unfrequently reduced to a single valve; 2. *Poinæ*, locusta 1- 2- or many-flowered, the outer or lower floret always perfect. Among the species are Wheat (*Triticum*), Oats (*Avena*), Barley (*Hordeum*), Rye (*Secale*), Rice (*Oryza*), Maize (*Zea*), and other cereals; also the grasses-proper, as *Phleum*, *Poa*, *Festuca*, *Anthoxanthum*, &c. Among remarkable foreign genera are Bamboo (*Bambusa*), Sugar (*Saccharum*), and the Tussac-grass of the Falkland Islands (*Dactylis cæspitosa*). One species, *Lolium temulentum*, or Darnel-grass, is believed to be poisonous. (*Graminaceæ*, Lindley.)

RHIZOGENS.

The anomalous plants which compose the class of Rhizogens or Rhizanths, constitute a singular transition series between the two Sub-kingdoms of Vegetables. Destitute of stems or of true leaves, they present an amorphous appearance, closely resembling various *Fungi;* but being furnished with flowers containing undoubted organs of fructification, they are entitled to rank among *Phanerogamia.* Their mode of life is parasitic, being attached to the roots or stems of various plants; they are never green, but are generally brown or some dull colour, and they stain any fluid, in which they are immersed, red. The species have hardly any economical importance; some which contain an astringent principle have been employed as styptics. The most curious among them is the Brobdignagian Javanese parasite *Rafflesia,* named in honour of Sir Stamford Raffles, the flower of which can hold about twelve pints of fluid.

V. CLASS.—RHIZOGENS (Rhizogenæ).

Leafless; often stemless; never green; flowers usually monœcious or diœcious; fructification springing from a thallus. Parasitic.

1. FAMILY.—*Patma-worts* (Rafflesiaceæ). Stemless; flowers sessile on the branches of trees, solitary; perianth superior, 5-lobed, with *calli* in the throat; anthers attached to a column, 2-celled, dehiscing by pores; ovary 1-celled;

styles conical; ovules 00, attached to parietal placentæ; fruit an indehiscent pericarp, polyspermous. Occur on the stems of *Cissi* in the East Indies, and in South America on leguminous branches. Among the species are the gigantic *Rafflesiæ* of Java, the flowers being occasionally three feet in diameter.

2. FAMILY.—*Cistus-rapes* (Hydnoraceæ). Flowers bisexual or unisexual, in spikes at the end of a scaly stem, the males uppermost; perianth 3-6-lobed; anthers sessile on a column, 2-celled, dehiscing by slits; ovary inferior, 1-celled; ovules 00, on parietal placentæ; fruit baccate, coriaceous, 1-celled, polyspermous. Found on roots of *Cistus* in Southern Europe, also on roots at the Cape of Good Hope. *Hydnora Africana*, smells like tainted roast beef.

3. FAMILY.—*Cynomoriums* (Balanophoraceæ). Fungoid; stems amorphous, horizontal; peduncles scaly; flowers monœcious, spiked; male flowers pedicellate, perianth 3-parted; stamens 1-3, epigynous; anthers and filaments united; ovary inferior, 1-2-celled, 1-2-seeded; style one; stigma simple; ovule solitary, pendulous; fruit 1-celled, 1-seeded. Inhabit tropical Asia and America, also the Cape of Good Hope; one species, *Cynomorium coccineum* (Fungus Melitensis), is found in Gozo, near Malta.

FLOWERLESS-PLANTS.

Flowerless-plants, corresponding with the *Cryptogamia* of Linnæus, comprehend all the remaining forms of vegetable life, and are extremely numerous in individuals, and even in species, of which latter, above twelve thousand have been described, included in about twelve hundred genera. They are separated into two great classes, in one of which an approach is made in general configuration, in structure, and even in the mode of their fructification to the higher forms of vegetation, while the other descends to mere aggregations of vital cells. Their principal characteristics consist in the absence of true flowers, and of distinct sexual organs, such as are found in the more highly developed classes, reproduction being effected by means of acotyledonous, reproductive bodies named spores, which are formed either in their interior, or on their surface, by the union of (at least in acrogens) two differently endowed cells. In size they vary from the lofty tree-Fern to the minute Lichen or microscopic fungus. In many leaves are quite wanting, and where a stem exists, it appears to be composed, unlike that of Endogens or Exogens, of a mere junction of the bases of leaves, the growth being Acrogenous, or on the summit.

In fossil- or Geo-phytology, Cryptogamic plants occupy an important position, as they appear to have been among the earliest forms of vegetables, their remains being very numerous in palæozoic strata, especially in the carboniferous series. Those most abundantly met with are *Filices*, *Equisetaceæ*, and *Lycopodiaceæ*, the latter of gigantic dimensions; also a few mosses and sea-weeds. In more recent formations, the proportional numbers of *Cryptogamia* are much lessened; and in the later deposits, the various classes of fossil vegetables bear nearly the same ratio to each other as in the existing Flora.

II.—SUB-KINGDOM. FLOWERLESS-PLANTS (*Cryptogamia*).

Flowers wanting; fructification by means of spores; sexes wanting or indistinct; germination heterorhizal.

ACROGENS.

The more advanced cryptogamic plants, into the composition of which vascular tissue enters, and which, in many respects, approach some *Phanerogamia*, have been separated, as a distinct class, under the name of Acrogens, or Cormogens. In them a stem and leaves can be distinguished; flowers are absent, but they seem to be represented in some instances, by the mode in which the leaves are arranged round the spore-cases of Urn-mosses, or by the involucrate membrane surrounding the *thecæ* of some Liver-worts. Among their reproductive organs two forms are generally present, which many writers distinguish as male and female, under the names of

Antheridia, and *Pistillidia* or *Archegonia;* and, from late observations by Hofmeister, Suminski, and others, the existence of sexuality among these plants is rendered highly probable.

Acrogens comprehend first the Ferns, numbering more than two thousand species, in which the fronds seem to represent branches, and the *ramenta* true leaves; these are often diminutive and inconspicuous in northern regions, but in tropical and subtropical climes, they are frequently arborescent, raising, at times, their graceful forms to the height of thirty or forty feet; next, the Club-mosses and Pepper-worts—small herbs, with a world-wide distribution; and lastly, the True-mosses, including the Liver-worts and Horse-tails, nearly equalling the Ferns in multiplicity of species, some of which are said to form the first appearance of vegetation on a new soil, and to be among the last occupants of exhausted lands or of an inappropriate clime.

This class supplies man with but few useful plants. The roots of some Ferns are esculent; and one species, *Nephrodium* (*Aspidium*) *Filix-mas*, is employed in medicine. The powdery contents of the spore-cases of some species of *Lycopodium* are highly inflammable, and, under the name of vegetable-sulphur, or witch-meal, are used in pyrotechny.

I. CLASS.—ACROGENS (Acrogenæ).

Stem and leaves distinguishable; surface furnished with stomata.

I. ORDER.—Filicals (Filicales).

Vascular; spore-cases marginal or dorsal, 1-celled, usually surrounded by an elastic ring; spores of only one kind.

1. Family.—*Danœa-worts* (Danæaceæ). Occasionally arboriform; spore-cases exannulate, appearing sunk within, or seated upon the back of the leaflets, conjoined more or less by their inner faces, opening irregularly by a central cleft. Tropical species in both hemispheres.
2. Family.—*Ferns* (Polypodiaceæ). Herbaceous, shrubby, or aborescent; spore-cases on the back or edge of the fronds, pedicellate or sessile, distinct, annulate, bursting irregularly. Inhabit especially moist, insular situations, and are very abundant in tropical islands; less numerous on continents. Some, as *Nephrodium Filix-mas*, have been used in medicine.
3. Family. — *Adder's-tongues* (Ophioglossaceæ). Herbaceous; spore-cases exannulate, distinct, 2-valved, collected into a spike formĕd out of the sides of an altered frond. Principally select tropical, insular situations, but occur also in temperate regions.

II. ORDER.—Lycopodals (Lycopodales).

Vascular; spore-cases axillary or radical, 1- or many-celled; spores of two kinds.

1. Family.—*Pepper-worts* (Marsileaceæ). Herba-

ceous; stemless, creeping or floating; leaves often stalked; vernation circinnate; reproductive organs enclosed in an involucre, and of two kinds—1, membranous sacs, clustered, stalked, or sessile, containing minute granules; 2, membranous sacs, containing cells, which divide into four, only one of which germinates. Inhabit ditches and wet places, chiefly in temperate countries. (*Rhizocarpæ*, Agardh.)

2. Family.—*Club-Mosses* (Lycopodiaceæ). Herbaceous, moss-like; stems creeping or corous; leaves imbricated, sometimes subulate; spore-cases axillary, sessile, 1-3-celled, dehiscing by valves, or indehiscent; at times of two kinds, the *one* enclosing minute, powdery matter, the *other* containing a cell, which produces four germinating bodies. Most abundant in warm, humid situations, especially in tropical islands; but occur also in cold climates.

III. ORDER.—Muscals (Muscales).

Cellular or vascular; spore-cases either plunged in the substance of the frond, or enclosed in a cap-like hood.

I. *SUB-ORDER.*—Operculate-Mosses (Musci).

Operculum present; no elaters.

1. Family.—*Urn-Mosses* (Bryaceæ). Cellular; erect or creeping, terrestrial or aquatic; leaves minute, imbricated, entire or serrated; repro-

ductive organs of two kinds, viz., *Antheridia* and *Archegonia;* spore-cases valveless. Inhabit damp places all over the world, but are more common in temperate latitudes.

2. FAMILY.—*Split-Mosses* (Andræaceæ). Branching, reddish or brown; leaves imbricated, ribbed or rib-less; spore-case opening by four equal valves, whose summits are always bound together by the persistent operculum. Found in temperate and cold countries, especially in bleak and rocky places.

II. *SUB-ORDER.*—INOPERCULATE-MOSSES (Hepaticæ).

Operculum wanting; usually furnished with elaters.

3. FAMILY.—*Horsetails* (Equisetaceæ). Stems simple or branched; fistular, jointed, siliceous; branches in whorls, at the articulations of the stem; leaves represented by the green coloured branches; stomata arranged longitudinally on the cuticle; spore-cases peltate, opening inwards by a longitudinal fissure; an elater to every spore. Widely distributed; occur in lakes, ditches, and rivers.

4. FAMILY. — *Scale-Mosses* (Jungermanniaceæ). Creeping, moss-like; leaves imbricated, very cellular, round a central axis, or with the leaves and axis fused into one common leafy expansion; spores opening by four equal valves, mixed with elaters. Distribution ex-

tended, but abound more in tropical, shady woods.

5. Family.—*Liver-worts* (Marchantiaceæ). Stem or axis leafless, but bordered by membranous expansions which sometimes unite at their margins, forming a broad lobed frond; spore-cases in heads, stalked, opening by irregular fissures, or by separate teeth; spores globose. Inhabit damp, shady places, everywhere.
6. Family.—*Crystal-worts* (Ricciaceæ). Submerged or floating plants, usually annual; leaves and stems blended into a cellular frond; spore-cases membranous, decaying so as to permit the spores to escape; elaters none. Most abundant in Europe, but occur also in most parts of the world.

THALLOGENS.

With Thallogens we reach the extremes of another primary division of nature, those confines where the vegetable and animal forms of vitality appear to encroach upon each other, where cell-life in its most simple and primitive form puzzles alike the Phytologist and the Zoologist. In the great anxiety which has been evinced to come to a determination on this point, it has been alleged that there is an intermediate stage, by which the one kingdom passes into the other, and some have fancied that they have actually traced this strange transformation, so that certain minute existences are, at one portion of their life animal, and at another, vegetable. Such novel speculations may, perhaps, be ascribed to the acknowledged difficulty of ascertaining what is the essential characteristic which distinguishes two, apparently similar, vivified globules, what it is that determines the one to be phytous and the other zoous. And yet that such a primary separation exists in reality, though not easily appreciable to our senses, can hardly be doubted, when we see their varied effects. That many of the simpler orders should at different times be looked upon either as plants or as animals, is easily to be accounted for, according to the view of the observer, but that the two are connected by direct transition, seems not probable, as their vitality differs not only in degree, but also in kind. The one more sthenic, more intense, giving tone to the fibres, and irritability to the nerves, capable of producing quicker and more marked effects, but sooner wearing itself out, and therefore less lasting,—the other more chronic, more deficient in positive strength, but, often more enduring, and adapted for supporting the more simply constructed members of the Vegetable World.

The marks of animal life have already been alluded to at page 2, so that it is merely requisite to say, in addition, that recent researches have shewn that starch granules form part of the contents of many cells, and when they can be detected, no doubt need be entertained of the vegetable nature of the object under investigation. But the present amount of our knowledge, while allowing us gradually to approximate truth, does not enable us finally, as yet, to arrive at the settlement of this important question. In the lowest members of both kingdoms, sexual distinctions are either wanting or extremely obscure, and increase seems to be effected by a spontaneous multiplication of cells. So far, therefore, both are alike, but here the resemblance ceases; as we advance upwards in the Zoological series, we first find beings in whom the sexes are united, but afterwards male and female are completely separated, which is invariable in the higher animals. Among vegetables, again, the existence of the two sexes in distinct individuals is more general, rather low down in the scale, while hermaphroditism seems to be the normal condition of the most advanced plants. A difference in the sources of movements in these two elementary forms is highly probable, and may be further established by analogy with the more developed beings of either class. The one seems more the result of internal causes, originating, perhaps, in a kind of instinctive volition, while the other would appear to depend rather on external agents, and to be more allied to irritability.

Among Thallogens are ranked, first, the Lichens, denizens of forest, of mountain, and of plain, ranging from the torrid zone to frozen climes;—curious little plants, their gracefully twisted and often silvery fronds at times giving a venerable appearance to the trees whose trunks they frequently clothe, or covering with their stunted forms arctic rocks, and there, in his hour of need, often affording to man a scanty sustenance, enabling the polar traveller somewhat to mitigate the pangs of hunger. Next are the Fungals, often parasitic, or springing from dead or decaying matter, confined within no narrow bounds,—sometimes arranging themselves in circles, and popularly known as "Fairy-rings,"—frequently springing up in a night, increasing in size, and arriving at a short-lived maturity ere noontide, and disappearing with declining day, so as to cause any rapid growth or sudden uprise to be denominated "fungoid," from its resemblance to these unstable and often noxious plants. Lastly, we have the Algals, mostly aquatic, filling ocean and sea, river and lake, with innumerable individuals, forming sub-marine forests at least equalling in extent those of dry land, or as more minute existences in ponds and still waters, rivalling the sands of the sea-shore in their countless myriads. The "Brittle-worts," the last division of the Algals, constitute a most perplexing family, whose relations are not easily comprehended, and whose position as vegetables is more influenced by strength of analogy than by positive right. Here it is that we arrive at the debateable land, the disputed territories,—a most perplexing question, fruitful in dispute, and until both sides are fully heard, and their respective titles accurately examined, only to be provisionally settled by arbitration between the belligerent naturalists who have ranged themselves with either party.

II. CLASS.—THALLOGENS (Thallogenæ).

Entirely cellular; stems and leaves undistinguishable; stomata none; reproduction by spores.

I. ORDER.—LICHENALS (Lichenales).

Live in air; nourished through their whole surface by the medium in which they vegetate; propagate by spores, which are usually enclosed in asci, and have always green gonidia in their thallus.

1. FAMILY. — *Scutiform - Lichens* (Parmeliaceæ). Nucleus bearing asci; thallus heterogeneous, pulverulent, or cellular. Several yield dyes, as Cudbear, from species of *Lecanora;* Litmus, from various *Roccellæ* and *Variolariæ;* others afford nutritive matter, as Iceland-Moss (*Cetraria Islandica*), and some species of *Sticta*, also *Cladonia rangiferina*, or Reindeer-Moss.
2. FAMILY. — *Glutinous - Lichens* (Collemaceæ). Nucleus bearing asci; thallus homogeneous, gelatinous, or cartilaginous.
3. FAMILY.—*Graphic-Lichens* (Graphidaceæ). Nucleus breaking up into naked spores; apothecia resembling Oriental characters. Some kinds supply a scanty nutriment, as species of *Gyrophora*, which, under the name of "Tripe de Roche," is occasionally the principal subsistence of northern hunters and Arctic travellers.

II. ORDER.—Fungals (Fungales).

Living mostly in air; nourished through their thallus; reproduce by spores, which are sometimes enclosed in asci; green gonidia wanting.

I. *SUB-ORDER.*—Sporiferous-Fungals (Sporiferi).

Reproduction by spores attached externally, and often supported on sporophores.

1. Family.—*Membranous-Fungi* (Agaricaceæ). Hymenium distinct, naked; receptacle long or expanded, superior; spores generally quaternate, on distinct sporophores. To this family belong many edible species, chiefly *Agarici* and *Boleti;* some, again, as *Amanita*, are poisonous; *Polyporus* and *Merulius* are the chief agents of destruction in what is termed "dry-rot" in timber. (*Hymenomycetes.*)
2. Family.—*Ventricose-Fungi* (Lycoperdonaceæ). Hymenium enclosed in a membrane (peridium); spores generally in sets of four, on distinct sporophores. The genera *Phallus* and *Bovista*, are remarkable for the extreme rapidity of their growth; *Lysurus mokusin* is applied by the Chinese to foul ulcers; *Ileodictyon* is eaten in New Zealand. (*Gasteromycetes.*)
3. Family.—*Blighting-Fungi* (Uredinaceæ). Spores single, often partitioned, on more or less distinct sporophores; flocci of the fruit obsolete or mere peduncles. *Puccinia* and *Uredo*

are popularly known as "smut" in corn. (*Coniomycetes*, Fries.)

4. FAMILY.—*Botrylloid-Fungi* (Botryaceæ). Spores naked, often septate; thallus floccose. *Botrytis* is the cause of a disease in silk-worms; *Penicillium* appears on books in the form of blue mould. (*Hyphomycetes.*)

II. *SUB-ORDER.*—SPORIDIOUS-FUNGALS (Sporidiiferi).

Reproduction by spores enclosed in asci (sporidia).

5. FAMILY.—*Follicular-Fungi* (Helvellaceæ). Hymenium distinct, superior, margined; receptacle urceolate or reflexed, inferior; sporidia generally eight together. Several are esculent, as *Helvella, Tuber, Morchella; Mylitta* is eaten in Australia, and a *Cyttaria* supplies food to the inhabitants of Tierra del Fuego; the species of *Sphæria* grow principally upon caterpillars. (*Ascomycetes*, Berk.)

6 FAMILY.—*Vesicular-Fungi* (Mucoraceæ). Spores surrounded by a vesicular veil or sporangium; thallus floccose. Species of *Mucor* enter into the composition of mildew. (*Physomycetes*, Berk.)

Many fungi are not yet sufficiently understood to enable them to be classified, among which are Ergot of rye, *Spermoëdia clavus* of Fries, or *Ergotætia abortifaciens* of Queckett; also *Mycoderma*, found in flour, yeast, &c., and the vegetable crusts appearing in some skin-diseases in man, as in *Mentagra*, and *Tinea favosa.*

III. ORDER.—ALGALS (Algales).

Living in water or very damp places; nourished through their whole surface by the medium in which they vegetate; propagated by zoospores, coloured spores, or tetraspores.

1. FAMILY.—*Stone-worts* (Characeæ). Aquatic, submersed; odour fetid; colour dull-green; a central stem or axis, often encrusted with carbonate of lime; branches in regular whorls, symmetrical, tubular; organs of reproduction round brick-red globules, and axillary oval nucules, the latter containing starch-granules. Occur in salt-water, or in stagnant fresh-water in all parts of the world, but more abundantly in temperate climes.
2. FAMILY.—*Rose-tangles* (Ceramiaceæ). Sea-weeds; rose-coloured or purple; bodies cellular or tubular, unsymmetrical; reproduction by tetraspores enclosed within a transparent perispore, and collected in bodies of different forms. All marine plants, chiefly inhabiting from 35° to 48° N. lat., diminishing towards the equator and the pole; rare in the Southern Hemisphere. Several gelatinous species are employed as food, as *Chondrus crispus* or Carrageen; *Rhodomenia palmata*, or dulse; and *Laurentia pinnatifida*, or pepper-dulse; *Plocaria tenax* yields a matter used by the Chinese as glue and varnish.
3. FAMILY.—*Sea-weeds* (Fucaceæ). Bodies cellular

or tubular, unsymmetrical; fronds of one or many cells, often united by gelatinous matter; reproduction by single spores, contained in superficial cells, which are scattered through the whole frond, or situated in particular parts of it. Distribution universal; marine or fresh-water. Some attain a considerable size, as *Scytosiphon filum* of the North Sea, or *Macrocystis pyrifera* of the Pacific, the latter said to be occasionally upwards of 1000 feet in length; *Sargassum bacciferum*, met with in large floating masses, is known as gulf-weed; "kelp," employed in the manufacture of glass and soap, is composed of the ashes of *Fucus vesiculosus*, *F. serratus*, and *F. nodosus*, the kind which is used for obtaining Iodine and Bromine, is chiefly made from *Laminaria digitata*, *Himanthalia lorea*, and *Scytosiphon filum*.

4. FAMILY. — *Joint-worts* (Confervaceæ). Bodies vesicular, filamentary, or membranous; colour usually green; cells solitary or many, variously shaped and disposed; reproduction by zoospores generated in the interior, at the expense of the green matter. Universally found, generally in fresh-, but occasionally in salt-water, also in mud, on rocks, or parasitic. Some occur in such numbers as to colour the waters they inhabit, as *Trichodesmium erythrœum* in the Red Sea, or *Oscillatoria ærugescens*, which gives a green tint to Glaslough

in Ireland; the appearance described as "Red Snow" is caused by *Protococcus nivalis;* some, as *Ulma thermalis*, live in hot springs.

5. Family. — *Bond-weeds* (Desmidiaceæ). Bodies cylindrical, bipartite; colour green; highly mucous, destitute of silex; multiply by spontaneous separation; reproduction by bodies analogous to zoospores. Usually found in cloudy masses near the bottom of permanent old boggy pools. The cells of Bond-weeds contain starch granules.

6. Family. — *Brittle-worts* (Diatomaceæ). Bodies crystalline, angular, fragmentary, very brittle; contain much silex; composition not binary; colour dark brown; multiplication and reproduction as in the last family. Inhabit still waters, and boggy places, chiefly in temperate and northern climes.

PART III.

GEOLOGY.

THE STRATA COMPOSING THE EARTH'S CRUST ARRANGED ACCORDING TO THEIR RELATIVE POSITION.

I. SECTION.—DESCRIPTIVE GEOLOGY.

THAT grand poem has not yet been written wherein the wonders of the changing epochs of the world's early history shall be pourtrayed, as by the pen of some pre-adamite and gifted being, who, having passed unscathed through all the revolutions of our planet, shall record the result of his kosmical experiences. I have watched, he might declare,

> "The proteus shape of nature as it slept,"

and have seen the sullen ocean heaving waveless over the heated, new-formed crust, and heard no sound save the snap of armour-clad and buckler-headed fishes, as they caught strange floating mollusks swarming in the deeps, "their dark nativity." And, amid these fishes of surprising shapes—their bodies covered with enamelled plates—were others, shark-like, ravaging the waters of that wide ocean; while among the fuci and branching zoophytes that clothed the heated rocks, were slug-like Nudibranchs, whose forms have now for ever perished. I have traced the habits and development of the curious crab-like Trilobites, and gazed upon the shoals of strange-formed Cephalopods that sported near the surface. I have seen, clothed with darkling vegetation, islands clustered on the wide expanse, whose shores then teemed with Lily-Encrinites and ponderous Madrepores. High-rising, in the carbon-laden atmosphere, were Club-mosses eighty feet in height, with leaves of similar proportions; here flourished also sombre pine-like trees; Horse-tails, with succulent and jointed stems, surmounted by their scaly catkins, arborescent Ferns, marsh-loving *Stigmariæ*, Mosses, Lichens, and gigantic Fungi. No flowers adorned the scene—no insect hordes enlivened the air—no gambolling of monkeys was seen among the trees, nor were heard hoarse notes of screaming, gaudy-tinted parrots. I have witnessed the burial of these vast primeval forests, and seen them turned to coal. In gloomy swamps I found the home of *Archegosaurus*—that monstrous form, half-toad, half-lizard—pursuing awkwardly the insect tribes around it, and followed with a fearful eye those great and sauroid fishes that ravaged with a greedy voracity these ancient waters. Another epoch, and lo! the waters had subsided, and the flat and muddy shores were tenanted with reptile life. That giant Newt *Labyrinthodon*, appeared to my astonished sight, leaving, as he moved along, lasting imprints of his huge and hand-like feet.

"In contemplation of created things,"
I have sat beneath the shade of crown-topped Cycads, and heard the oft-repeated plunge, and watched the gnome-like movements of those new-made Saurian forms, the Fish-Lizards, as they gambolled in the turbid waters, or basked along the reeking mud-flats, while, as the day declined, Pterodactyles, bat-like Lizards, would flit among the trees above my head, snapping their bird-like jaws. Half-hid among the Horse-tails of the swamps, that "biggest born of earth," the reptile *Mosasaurus*, waited warily for prey; on the banks of mighty rivers I saw the colossal *Iguanodon*, roaming harmlessly, and browsing on the juicy herbage; in the shadowy woods, that huge basalisk, *Hylæosaurus*, lurked and lived; while long-jawed Crocodiles, and large web-footed Terrapins, usurped the marshes. I observed, too, marsupial mammals, like monstrous Kangaroos, hopping about vast arid plains, cropping the scanty herbage. Another epoch has elapsed, and another tribe of beings enter on the scene, thick-skinned and snouted, "enormous in their gait," wallowing in estuaries, and seeking their food in jungle and savannah. I saw the *Dinotherium* tearing up the banks, or suspended by his tusks to the shores of inland lakes; I watched the fur-clad Mammoth feeding in the arctic wilds; and admired the proportions of the great Elephant of the Lena; I gazed with wonder on the moving mass of the shielded *Glyptodon;* and paused to watch the sloth-like *Mylodon* seated on its haunches, tearing the

bark from primeval forest-trees. On vast and solitary plains I have encountered the *Megatherium*, "huge of bulk," rooting up the herbage with his powerful, his devastating claws; and again, have watched the rapid paces of the *Epyornis* as he strode along the grassy valleys, huge, powerful, and ostrich-like.

Amidst these changes of organic life, I have witnessed, with awe, the throes of nature, as mountains were upheaved, craters belched forth liquid fire, and lava swept along the plains. I saw that mighty torrent moving resistlessly forward, bearing in its course rock-masses, and destroying all those tribes of living forms whose bones are found in caverns at the present day; and noted, with amaze, the resting-places of those mighty boulders borne by icebergs on the bosom of this fearful deluge. I have seen the retiring waters finally leave broad and solid tracks, soon to become verdant with ten thousand varied trees, redolent of life,

> "The breath of nature and her endless bloom."

The following pages comprise a simple compilation of the chief facts and features of modern Geology; the strata of the Earth's crust being thrown into several classes of formations, the chief peculiarities of which are defined, the geographical distribution mentioned, and their principal organic remains briefly alluded to.

I. CLASS.—HYPOGENE-FORMATIONS.

This class, comprising the Granitic and Trap Rocks, the Gneiss, and Mica-Schist, is composed of hard, compact, crystalline strata, and solid rocks of quartz and mica. Granite, syenite, hornblende, serpentine, together with basalt, chink-stone, and clay-stone, also occur, and organic remains are absent.

I.—The Granite-Basis.

The unstratified and crystalline granite basis, on which all the other formations rest, is generally believed to have resulted from the gradual cooling of the earth when liquified by intense heat. The crust of solid granite thus formed, is estimated at sixty to one-hundred miles thick, and it is imagined that it will continue to increase in thickness as the process of cooling goes on. This granite crust is flexible, and the expansive force which the fluid nucleus exercises upon it, is believed to occasion the phenomena of earthquakes. Portions of it are found protruding above the other strata in every part of the globe, often rising up in extensive mountain-chains, as in the Andes of South America, the Abyssinian ranges of Africa, the Pyrenees of Spain, the Grampians of Scotland, the Alps of Switzerland, and the Cornwall hills of England.

1.—*Common Granite* is composed of felspar, quartz, and mica; when hornblende is present instead of mica, it is *Syenite;* when talc takes the place of mica, it becomes *Protogine;* when it is formed of quartz and hypersthene, with scattered crystals of mica, it is *Hypersthenic-granite;* when it is mottled with chlorite, it is termed *Serpentine;* and when larger crystals of felspar are scattered indiscriminately through it, *Porphyry* is the result.

On account of its extreme hardness and durability, granite is chosen for the construction of important works, as bridges, docks, and lighthouses; the enduring monuments of ancient Egypt, the Pyramids and Colossal Sphynx, are formed of granite; talc is often used for windows, and decomposed felspar is employed in the manufacture of china. Many Eastern works were formed of *Syenite,* which is harder than granite; and columns, monuments, and ancient antique works are frequently of red, brown, green, or black *porphyry.* The *verde antico,* or green porphyry of the ancients, is composed of greenstone, with scattered crystals of white and green felspar. *Basalt* is used in the formation of sea-walls, and for road-stones; some of the Sphynxes and Lions sculptured by the Egyptians, are of this substance. *Trachyte,* and felspathic lavas, are sometimes employed as building materials, as *tufa,* used by the Romans at Pompeii; and *Serpentine* or Ophiolite, a bisilicate of magnesia, has been used extensively in the manufacture of idols, columns, vases, and ornamental work.

2.—The *Trap Rocks* comprise the Basalts and Porphyries, and commonly occur in the shape of veins or dykes, as in the felspar porphyry rising through the granite which constitutes the base of

Ben-Nevis, and in the porphyry vein at St. Agnes, Cornwall. The columnar Basalt is well shewn in Fingal's Cave in the Isle of Staffa, and in the Giant's Causeway, in Ireland. No certain traces of organized beings have been detected in these rocks.

II.—GNEISS GROUP.

This group is formed by layers of gneiss, syenite, and quartz rocks, alternating with clay-slate, mica-schist, &c., forming the lower portion of the primary stratified rocks. *Gneiss* is composed of the same elements as granite, but these are arranged in contorted or undulated layers, appearing as if produced by the disintegration of granite, and then deposited in water. The summits of gneiss mountains are usually rounded, and numerous beds and veins of metals occur in this formation. The ocean which deposited the mica, quartz, felspar, &c., was probably of too great a temperature for the support of animal life, no organic remains having been found in the strata of this group.

III.—MICA-SCHIST GROUP.

This group is composed of mica and quartz, interlaminated so as to present the appearance of stratification; crystalline limestone and hornblende also occur; and the lower strata consist of greenish-coloured slates, with mica and talc, schist, chlorite, and quartz rock. In the mica-schist and other metamorphic rocks, altered by high temperature, metallic ores are found in the greatest abundance.

Swedish *iron* is procured from rocks of this class, forming mountain-masses in Smoland; as is also the Elba, or opercular iron. *Manganese* has been also procured from the rocks of this group; and in gneiss and mica-schist, the most important *copper-ore* (or pyrites) occurs on the Continent, and in Cornwall and Ireland; *lead*, in the form of *galena*, or bisulphuret, is present in these rocks, as well as in the fossilliferous deposits; *silver*, as a bisulphuret, is found in green-stone, clay-slate, and syenite, the veins sometimes extending, as in Mexico and Peru, to the ordinary deposits. *Tin*, in the shape of binoxide, occurs in granite, and in "killas," a peculiar schist in Cornwall, and in other parts of the world; *mercury* is occasionally detected dispersed in globules in granite, but the rich ore of this metal, *cinnabar*, is from the primary or grauwacke strata of Almaden, in Spain; *antimony* and *molybdenum* are also found in granite, gneiss, and mica-schist; and *gold* has been found disseminated in quartzose and chloritic rocks in Brazil, and in various parts of the earth it is extracted from auriferous sands, produced by the decomposition of these strata, as are likewise *platinum* and *diamonds*. *Flexible asbestus*, or amianthus, is found among the mica-schists, as are also *garnets;* and some of the limestones produce valuable marbles.

II. CLASS.—PALÆOZOIC-FORMATIONS.

The different groups composing this class have, until of late years, been arranged partly with what were formerly called primary rocks, and others with the secondary formations. Some were separated, under the name of "transition-rocks," but they have since been more accurately defined, and named *Palæozoic*, from their containing the first remains of organized existence. They comprise the Silurian system; the Devonian, or old Red-Sandstone; and the carboniferous strata; to which Murchison has added the Permian, or magnesian-limestone system.

I.—THE SILURIAN GROUP.

This group constitutes a series of marine deposits of vast extent, composed of sandstones, limestones, shales, grits, flagstones, and slates. It derives its name from the *Silures*, who formerly inhabited those districts of Britain where the strata occur most conspicuously. The Silurian strata extend from the heart of South Wales to that of England, in Russia, in the Falkland Islands, and in North America; they are also found in widely-extended beds abounding in the remains of fishes, mollusks, crustaceans, and polyps. The deposit termed *Cambrian*, the earliest known fossiliferous formation, occurs in North Wales, and is placed under the Silurian strata; it consists of slaty and gritty beds. The *Murchisonian*, or *Upper Silurian* rocks, are composed of gray and bluish limestones, coloured micaceous shales and flagstones. The *Lower Silurian* rocks are formed of impure shelly limestone, mottled sandstones, and dark calcareous flags, and occur in Belgium, along the banks of the Rhine, in Westphalia, the North of Germany, the extreme parts of Russia, and in the lake region of North America.

In this formation the first traces of organic life are met with. The vegetable remains are few, and chiefly of the lower orders, as algæ, ferns, and horse-tails.

Eight hundred and forty-five species of animals have been described from the Silurian strata by M. D'Orbigny, and eleven hundred species of Invertebrata have been discovered in the Silurian system of Bohemia alone, including two hundred and fifty species of Trilobites. Only a few scales and bones of fishes, belonging to the genera *Sclerodus*, *Pterygotus*, *Thelodus*, and *Onchus*, have been detected. In this formation those singular crustaceans occur, belonging to an extinct tribe, comprising about six families, and numerous genera. These are the *Trilobites*, clad in mail, with large shield-shaped heads, and compound, sessile eyes. Among them we notice the *Illænus*, of an oval shape, and with the angles of the head rounded, an allied species (*Isotelus gigas*, *Dekay*) is eighteen inches in length; *Asaphus*, with the cephalothorax ending in a point on each side; *Bumastus*, or the "Barr-Trilobite," covered with undulating imbricated plates, all belonging to the family of *Asaphidæ*, having the power of rolling up their bodies like woodlice; these are found chiefly in the Lower Silurian group. Here, likewise, we have the curious *Homalonotus* of the Ludlow limestones, with its abdomen ending in a long point, and the *Calymene*, or "Dudley-Locust," with large trilobate head, besides *Cyphaspis*, *Phacops*, and *Œonia*, other members of the *Calymenidæ*. In the *Harpidæ*, where the sides of the segments are rounded, and the surface of the body is furrowed, we find the *Ellipsocephalus*, *Harpes*, and *Conchocephalus*, and among the *Olenidæ*, which were unable to roll themselves into a ball, we include, besides *Olenus*, the singular *Paradoxides*, with the lateral segments ending in long deflexed spines. *Brontes* was another remarkable form, having the lateral portions of the abdominal sections radiating and forming a fan-shaped expansion; this genus, with five *Odontopleuræ* and *Arges* formed another family (*Odontopleuridæ*), the members of which were also unable to roll themselves up. Among the *Ogygiidæ*, we find the *Trinucleus*, with the margin of the cephalic segment perforated, and *Ogygia* with the same part prolonged on each side into slender spines distinct from the body, and the family of *Eurypteridæ*, which were furnished with antennæ. *Tentaculites*, the tube of an Annelid allied to *Serpula*, is the only representative of other annulose animals; it is found in the Caradoc sandstone of the Lower Silurian strata.

Among Cephalopadous Mollusks the genera *Phragmoceras* and *Lituites* have been observed, but these chambered forms are very limited in number and size compared with their abundance, and the gigantic forms they assume in strata of the secondary formation. The Gasteropods, again, are much less numerous than the Bivalves. *Euomphalus*, an extinct genus, is common in the grauwacke limestones, and there are found also about ten species of *Turritella*, six of *Turbo*, five of *Buccinum*, *Delphinula*, and *Patella*, and three of *Nerita*, *Capulus*, *Trochus*, aud *Phasianella*. The bivalve *Mollusca* are not much more numerous than the spiral Gasteropods; the great majority of Silurian species appearing to have been either pelagian, like *Bellerophon* and *Orthoceras*, or inhabitants of deep water, as the Brachiopodous tribes. The bivalve genera of *Avicula* and *Cypricardia* occur in the Upper Ludlow strata, and *Lingula* in the Aymestry limestone. The *Brachiopoda* constitute about a fourth part of the Silurian Mollusks. Among them we find the *Pentamerus*, divided into four chambers; the *Spirifer*, with long spiral arms; the *Orthis*, with straight, narrow hinge; the *Atypa*, with a short hinge-line; besides *Terebratulæ*, *Producti*, *Gypida*, and *Chonetes*. The only Echinodermatous animal met with, is an *Ophiura*, belonging to the family *Ophiuridæ;* and the cup-like Encrinite, belonging to the Crinoid forms, remarkable for the jointed peduncle that supports their bodies. Among the Polypiferous animals, we here find the branched *Porites*, with rayed cells, and the polymorphous tribe of *Favosites;* besides these, the curious *Graptolithus*, belonging to the family of the Sea-Pens, was an inhabitant of the Silurian Seas.

II.—OLD RED-SANDSTONE GROUP.

This is a marine formation, composed of strata of marls, limestone, micaceous and gray sandstones, conglomerates, quartzose grits, crystalline limestone, and green slates; the prevailing colour of all being a dull red, derived from sesquioxide of iron.

In Britain this group is well represented in in the South of Devon, in Orkney, Caithness, and Cromarty; in Germany in the limestones of Eifel; in Russia, in a wide area south of St. Petersburgh; and in the United States, at the Falls of the Ohio. The *Tilestone* division is composed of finely laminated, hard, reddish, or green, micaceous quartzose sandstones, with occasional beds of reddish shale. The *Cornstone* division consists of red and green, argillaceous, and spotted marls, with alternating bands of sandstone, and with irregular courses of mottled, red and green cornstone, or impure limestone. The upper portion comprises the *Quartzose Conglomerates* and *Sandstones;* comprising quartzose-grits, and reddish quartzose conglomerates, passing into reddish coarse-grained sandstones, with alternating layers of red and green argillaceous marls. The Old Red-Sandstone is a marine formation, and is especially remarkable for the fossil fishes it contains, entire skeletons of ganoid and placoid families having been discovered. A solitary reptile has recently been brought to light by Mr. Duff, from the Elgin Sandstone, which appears to possess a mixed character between the Amphibians and the Saurians; it is the *Telerpeton*

Elginense of Mantell. Among the fossil fishes of this epoch, we may mention the *Ptychacanthus*, belonging to the family of Cestracions; genera of the curious extinct family of *Cœlacanthidæ*, with the rays in the form of hollow tubes, and the tail produced into an elongated style. To these must be added five genera of the family *Cephalaspididæ*, which have the head and front of the body covered with bony plates. The *Coccosteus*, with an armour of tuberculated bony plates, a round head and elongated tail; the *Cephalaspis*, or Buckler-head, with its large head with concentric horns, and narrow-jointed body; the *Holoptychius*, cased in large, carved scales; the *Pterichthys*, or Winged-Fish, with its coat of mail, strong spinous fins, and curious tail with the vertebræ extending as far as the end; and the *Polyphractus* and *Pamphractus*. To another and equally curious family, the *Dipteridæ*, belonged the *Dipterus* and *Diplopterus*, with their fins like two pairs of wings; the *Cheirolepis* with its scaly pectorals and small, fretted scales; and the *Osteolepis*, cased from head to tail in complete armour. To these we may add the *Glyptolepis*, with its large, sculptured scales; the *Cheiracanthus*, or Thorny-hand, with spiny pectoral fins; the *Acanthodes*, with a spine in each fin; the little *Diplacanthus*, covered with extremely minute scales; and last, not least, the highly interesting *Asterolepis*, or Star-scale, with its broad, plaited head, and body covered with scales of solid bone, so graphically described by Hugh Miller.

The crustaceans of this group comprise several genera of the Trilobite family, as *Calymene*, *Asaphus*, *Harpes*, *Homalonotus*, and *Brontes*.

Among the cephalopodic forms of molluscous animals, we find numerous genera of the family *Clymenidæ*, as the straight *Orthoceras*, with central siphuncle; the *Cameroceras*, with the siphuncle lateral; the discoidal *Clymenia*, with the siphuncle internal; the *Aturia*, with a large funnel-shaped siphuncle; and the curved, compressed, *Phragmoceras*. Among the cephalopods of this epoch, we also observe several members of the family *Ammonitidæ*, with their shells spiral, straight, or variously bent. Here we have the curved *Cyrtoceras;* the straight *Stenoceras;* the nautiloid *Gyroceras*, with the whorls disunited; and the *Goniatites*, with discoidal shell, and lobed sutures; besides upwards of one hundred and twelve fossil species of *Nautilidæ*, and among them the curious *Lituites*, with the last chamber produced, besides *Aploceras*, *Gomphoceras*, *Actinoceras*, and other extinct genera. The gasteropodous tribes are represented by *Pleurotomaria*, *Euomphalus*, *Bellerophon*, *Nerita*, *Natica*, *Megalodon*, *Calceola*, and *Strygocephalus;* and a little unknown bivalve has been found in this formation in the Orkneys.

The zoophytic remains are numerous, among which we may observe the beautiful honey-combed *Favosites* and the starred *Favistella*, the cup-shaped *Cyathophyllum*, the net-like *Fenestella*, and the elegant chain-coral *Catenipora*.

III.—CARBONIFEROUS GROUP.

This most extensive series is composed of shales, sandstones, ironstones, clays, millstone-grit, and limestone, in alternating strata of marine and fresh-water formation, interstratified with seams of coal.

The *Coal-measures* are formed of alternating beds of coal, shale, sandstone, and clay, with seams of nodulous ironstone. The coal itself consists of ancient plants, altered by chemical agency, and imbedded in sand and mud. Sometimes the plants grew where the coal now exists, or they were washed down into estuaries, forming vast accumulations. The coal-fields of the British islands are very numerous, and are found in South Wales, England, Ireland, and Scotland; the gross value of the collieries being upwards of nine millions sterling. Three millions five hundred thousand chaldrons are annually brought into London, in nearly ten thousand ships. There are also coal formations in New Holland, in the East Indies, in China and Japan, in Borneo and Labuan; also in our colonies of Newfoundland, New Brunswick, Nova Scotia, Cape Breton, Prince Edward's Island, New Zealand, and Port Natal. The position of the beds is often very different, many of the seams of Newcastle being worked under the sea, while at Chipo, which rises above the plain of Santa Fè de Bogota, coal is found 800 feet above the sea, and at Buanco, at 12,800 feet, or bordering on the limits of eternal snow.

Iron-ore or clay-ironstone, from which the valuable product *iron* is extracted, is also found in this formation, which thus produces the mineral, and the requisite fuel for smelting it. In 1846, two millions two hundred and fourteen thousand tons of iron, of the value of eight millions eight hundred and fifty-six thousand pounds, were produced in England.

Igneous Rocks are frequent in the Carboniferous group, sometimes occurring as overlying stratiform masses, alternating with sedimentary deposits, and frequently as dykes, penetrating through the strata. They principally consist of greenstone and basalt or whinstone, in the north of England, the mottled toadstone of Derbyshire, and the basaltic masses of South Staffordshire.

The *Mountain Limestone*, which naturally belongs to this group, is composed of thick-bedded, grayish limestones, and shales, with layers and nodules of chert, and ores of lead, zinc, and copper, with baryta, and fluor-spar. It is a marine deposit, abounding in the crinoid forms of Echinoderms, and the shells of cephalopodous and brachiopodous mollusks. It is extensively developed in the northern and western parts of England, rising in picturesque peaks and hills, as in Derbyshire, Cumberland, and Westmoreland. The mountain limestone of England is rich in lead, producing annually 30,000 tons, equivalent to about five hundred thousand pounds sterling; it occurs chiefly in the form of sulphuret of lead, or *galena;* manganese is also found in this formation, and valuable building-stones and marbles are likewise afforded.

Among the organic remains of the Carboniferous group, we may observe three species of the curious reptile, *Archegosaurus*, with the body of a toad and the jaws and teeth of a lizard, and the skin covered with long, narrow, tile-like, horny scales, arranged in parallel rows; foot-prints of other reptiles have been also discovered in the coal strata of the United States. The fishes comprehend *Pleuracanthus*, *Hybodus*, an extinct genus of Placoids, allied to the Sharks, *Amblypterus* and *Palæoniscus*, heterocercal Lepidoids, and *Megalichthys*, and *Acrolepis*, great heterocercal Sauroids, with large, pointed, conical teeth, the arch-tyrants of the ancient seas; also the placoid *Deplerus*, with scaly armour, and two dorsal, and two ventral, fins. The remains of Annulose animals comprise the fossil King-crab or *Limulus*, *Nebalia*, and *Apus*, with a few *Trilobites*, and several *Entomostraca*, as *Cypridella*, *Cypridina*, and *Cyprella*. Among Arachnidans, a scorpion (*Cyclopthalmus*), from the coal formation, near Prague, and among insects, *Curculionidæ*, several *Orthoptera*, including *Cridites* and *Blatlina*, and the neuropterous genus, *Corydalus*, may be enumerated. The molluscous forms embrace the cephalopodic, chambered shells of the straight, uncoiled *Orthoceras*, and the *Goniatites*, with the borders of the septa simple; while *Euomphalus*, divided into chambers, but without siphuncle, and the fragile *Bellerophon*, with *Turbo*, *Trochus*, *Turritella*, and

Nerita, are the most abundant of the carboniferous gasteropods. *Polypifera* of the genera *Cyathophyllum*, *Lithodendron*, *Syringopora*, and *Catenipora*, are numerous in the limestones.

The remains of ancient plants are numerous in this formation; the gigantic Tree Ferns, now confined to warm regions, constituted nearly two-thirds of the whole known fossil flora, and seem, at that period, as in New Zealand at the present day, to have replaced the graminaceous tribes, and to have covered extensive tracts with their delicate fronds and arborescent forms. Besides, however, the vast abundance of Ferns, large Coniferous trees related to species of warm climates, gigantic *Lycopodiaceæ*, and tribes related to the *Cactaceæ* and *Ricinaceæ*, were prevalent. Palms, and other monocotyledons, also *Calamites*, referred by some to the Horsetails, are also noticed.

Among the *Filices* may be discovered the round-leaved *Cyclopteris;* twenty-four species of Nerve-leaved fern, *Neuropteris ;* the elegant Tooth-leaved fern, *Odontopteris ;* sixty species of Embroidered fern, *Pecopteris*, with beautiful tripinnate leaves ; the Spear-leaved fern, *Lonchopteris*, and the Fissured fern, *Schizopteris*. Among the Club-mosses we find the *Lycopodites* with pinnate branches, the *Salaginites*, with dichotomous stems, and the *Lepidodendron* and *Ulodendron*, with the branches covered with scale-like leaves. Besides these, the *Lepidostrombus*, forming ovate cones of imbricate scales round a woody axis ; heart-shaped fruits or

Cardiocarpa, and *Stigmaria* with tubercles on the stem, arranged in a spiral manner; the *Asterophyllites*, with its star-like whorls, the leaves of *Flabellaria* and *Zeugophyllum*, the fruits of *Trigonocarpum* and *Musocarpum*, and about forty species of curious furrowed *Sigillariæ*, most probably the stems of extinct Coniferous plants.

IV.—PERMIAN, OR MAGNESIAN-LIMESTONE GROUP.

This formation is composed of fragments of mountain-limestone, coal, shale, &c., cemented together by a base of *dolomite*, or magnesian-limestone. The organic remains of this group exhibit some resemblance to those of the Trias, or New Red-Sandstone, but approach more closely to those of the Carboniferous.

The Permian system is developed fully in Russia, and derives its name from Perm in that country; in the south-west of England the beds are composed of dolomite; in the north-east, of a yellow magnesian-limestone, passing into slate, marl, and marl with gypsum. The magnesian-limestone is employed for architectural purposes, and was chosen as the best stone for building the New Palace at Westminster.

The organic remains at present discovered, comprise seven species of *Nothosaurus*, a reptile of the family of *Ichthyosauridæ*, and *Protosaurus* an extinct genus of *Lacertidæ*, from the Permian stage of

Tubingen. The curious Russian fish *Ommotolampes Eichwaldi* of Fischer, which is covered with bony shields like a tortoise, and the no less remarkable genus *Trachelocanthus*, which has a spine in its throat turned backwards, belong to this period. The other fish are remarkable for their heterocercal tails, in which the vertebral column extends into the upper lobe, as seen in the Shark and Sturgeon, which the fossil *Palæoniscus* probably resembled in its habits. The remains of molluscous animals are referred principally to the brachiopodous genera, *Productus* and *Spirifer*.

III. CLASS.—SECONDARY-FORMATIONS.

Secondary formations, as now restricted, are composed of various strata of sandstones, aluminous and siliceous beds, and chalky deposits; they commence with the New Red-Sandstone, and comprehend besides the Lias, the Oolitic series, including the Wealden-group, and the Cretaceous system. These rocks occur in all parts of the world, and abound in remains of plants and animals now entirely extinct.

I.—TRIAS, OR, NEW RED-SANDSTONE GROUP.

This is a marine formation, composed of variegated marls and sandstones, conglomerates, and limestones, frequently of a red colour, with extensive deposits of gypsum and rock salt, and containing numerous brine springs.

The lowest division consists of variegated sandstone, distinguished by greenish stripes and spots, and containing clay galls. The middle division, or *muschelkalk*, occurs under several varieties of limestones, which alternate with marls and clays, sometimes containing gypsum and rock salt. In the upper division, or *Keüper*, marls and clays, associated with gypsum and rock salt, and sometimes an impure coal occur.

Deposits of this system are extensively developed in France, Germany, Italy, European Russia, North America; and it traverses England from south-west to north-east. The organic remains of the New Red-Sandstone are tolerably numerous. A gigantic extinct species of Kangaroo has been found in fissures and caves of limestone of this epoch in New Holland, associated with the bones of the Wombat, and another marsupial mammal allied to *Didelphis*.

In the New Red-Sandstone of Massachusets fossil foot-prints of unknown animals, presumed to have been birds, have been observed. These imprints are of gigantic dimensions, being fifteen inches long and ten inches broad, and from four to five feet apart.

Among Reptilian remains, five species of *Labyrinthodon*, a kind of gigantic Batrachian, of littoral habits, with the jaws furnished with teeth, have been discovered in the lower stage of the New Red-Sandstone of England; it is supposed to have resembled a monstrous toad, and to have left the remarkable foot-prints on the muddy shores, resembling hands, which Kaup has referred to a supposed animal called by him *Cheirotherium.* From the Keüper of Germany are derived the extinct fossil forms *Mastodonsaurus, Metopias,* and *Capitosaurus,* belonging to the same family of *Labyrinthodontidæ,* and from the muschelkalk, *Diacosaurus, Simosaurus,* and *Pristosaurus,* genera of the extinct family *Ichthyosauridæ,* have also been obtained. Chelonians have left their foot-marks on slabs of New Red-Sandstone in the quarries of Dumfriesshire, which have been referred to *Chelichnus* and *Herpetichnus* by Jardine; moreover, the genus *Cladeiodon,* one of the *Lacertidæ,* is from the Keüper of Warwickshire, and the *Rhynchosaurus,* belonging to the same family, is from Grinshill. *Phytosaurus,* the most ancient Crocodile, is from the trias of Germany; and from the dolomitic conglomerate of Bristol we have the lacertine genera *Thecodontosaurus* and *Palæosaurus.* The fishes of this formation belong principally to the ganoid family of *Pycnodontidæ* and to the *Palæoniscidæ,* lepidoid fishes, with rhomboid scales arranged in parallel lines and with heterocercal tails. Among the mollusca the Cephalopodic family, *Ammonitidæ,* made its appearance here under the form of the genus *Ceratites;* the bivalves *Posidonia* and *Avicula* also occurred. From the muschelkalk, the echinodermatous *Encrinus,* or Lily-Encrinite, is obtained.

Among plants the epoch of the New Red-Sandstone formation was characterised by the appearance of a few *Cycadaceæ,* and must have resembled in its flora somewhat the aspect of that of New Holland. The curious arborescent fern, *Anomopteris*, the coniferous genera *Voltzia* and *Thuia*, the palmaceous *Cupressites*, and the flowering genera of *Æthophyllum*, *Echinostachys*, and *Palæoxyris*, also occur among the vegetable remains of this period.

II.—Lias Group.

This is a group of marine argillaceous limestones, stratified blue clays, alum shales, marls, and sandstones.

It extends throughout a great part of Europe; on the Continent, it occurs in the north and south-east of France, in Switzerland, and in Germany; and it forms a belt across our island, from Lyme-Regis in Dorsetshire to the north of Whitby.

The Lias was a marine deposit, of which the epoch was remarkable as the "age of reptiles;" gigantic saurians having then maintained possession of the shallow ocean, preying on the legions of cephalopods and other mollusks, and swimming around the muddy shores of the half-formed land.

The remains of the marine, air-breathing, cold-blooded *Ichthyosauridæ*, organized entirely for an aquatic existence, were especially numerous in the Liasic period of the secondary formations. Among the principal genera may be mentioned the Fish-Lizard, or *Ichthyosaurus*, with its short neck, great eyes, and reptilian head; and the *Plesiosaurus*, with crocodile's teeth, serpent's neck, and porpoise's paddles. The fishes comprise many ganoid genera, with equal-lobed, or homocercal tails; also fourteen genera of placoid *Cestraciontidæ*, with elongate bodies and tessellated teeth, of which *Acrodus* is one. The ganoid genera with homocercal tails, are principally *Lepidotus*, *Tetragonolepis*, *Dapedium*, *Amblyurus*, and *Semionotus; Chondrosteus*, a genus of *Acipenseridæ*, or sturgeons, is also from the Lias of Lyme-Regis.

While all the lepidoid and sauroid fishes which inhabited the seas before the deposition of the Lias had the vertebral column prolonged into the upper lobe of the tail, or were heterocercal, the fishes of the Lias group, with the exception of the *Coccolepis*, have the tail homocercal, like most of the fishes living in the seas of the present era.

The annulose animals found in this formation belong to crustaceans of the genus *Coleia;* species of *Astacus*, and minute entomostracous *Cyprididæ;* and, among insects, of coleopterous and orthopterous genera, including the beautiful neuropterous dragon-fly, *Æshna liassina*, and the remains of air-breathing annulose animals, cotemporaries of the gigantic marine saurians. Of molluscous animals, the Cephalopods were most abundant; vast numbers of *Ammonites* and *Belemnites*, several species of *Nautilus*, and the pens of *Loliginidæ*, have been brought to light. Among the gasteropodous tribes, we only meet with the genera *Rotella* and *Pleurotomaria*—bivalves, belonging to the genera *Gryphæa*, *Cardinia*, *Lima*, *Avicula*, and *Hippopodium*, have been found in the lower Lias shales; and

Crenatula, *Corbula*, *Pholadomya*, and *Nucula*, besides an *Arca*, *Pinna*, *Cardium*, and *Pecten*, in the higher beds; with *Posidonia*, and a large *Plagiostoma*. The brachiopodous genus, *Spirifer*, appears in the Lias for the last time; and *Leptœna* occurs in the neighbourhood of Ilminster. Of Echinoderms, we find the slender-armed *Ophiuri*, and elegant plant-like *Crinoidea*, chiefly belonging to the genus *Pentacrinus*. The *Cidaris*, a genus of Sea-Urchins (*Echinidæ*), is also found.

The plants of the Lias consist of *Zosterites*, a monocotyledonous genus; several *Coniferæ; Nillsonia*, and *Zamia*, of the cycadaceous family; the Tongue-fern (*Glossopteris*); the Wreath-fern (*Tœniopteris*); and the Lattice-fern (*Clathropteris*).

III.—THE OOLITE, OR JURA GROUP.

The Oolite comprises a series of marine strata of enormous extent, consisting of limestones, sandstones, and clays, with calcareous grits, replete with corals, shells, fish, reptiles, terrestrial plants, and species of mammalia. It occurs in England, commencing at the isle of Portland, follows a winding course through several counties, and ends at the sea, near Scarborough. On the Continent, it is developed in Normandy, traverses France, forms the mass of the Jura, and part of the Alps; and is found also in Germany, Poland, Portugal, and Spain.

The Bavarian Jura is celebrated for the lithographic stone of Solenhofen; in the lower division of the Oolites the Bath stone occurs so extensively used in delicate mouldings in architecture, and which is represented in France by the Caen stone; and in the upper Oolite the celebrated Portland stone is found, so useful as a building material.

With regard to organic remains, the Stonesfield slate has furnished us with three little quadrupeds of the size of a mole, allied to the Australian genus *Myrmecobius*, and belonging to the extinct genera *Amphitherium*, and *Phascolotherium;* they are of the lowest, or marsupial tribes of mammals: from the same place jaws of other marsupials, species of *Thylacotherium*, have been received. Reptiles of several descriptions peopled the ancient earth during this epoch, which was also an "age of reptiles."

Some, as the Pterodactyles, were organized for flying through the air like so many Vampire-Bats; others were adapted for frequenting river-banks and marshes, like the Crocodiles and the Monitors; and others were entirely marine, propelling themselves through the still, warm waters, by means of fin-like paddles.

The *Pterodactyli*, or Flying-Lizards, were most numerous during the Oolitic period, fourteen species having been discovered in the Oxford stage of Solenhofen alone; they are also found in the Stonesfield slate of Oxfordshire and Gloucestershire. These remarkable beings of a former creation were probably nocturnal, and differed from all living and extinct tribes of Reptiles, in the little finger of the fore-legs being greatly elongated and enlarged, to support a membranous wing, by means of which they were enabled to enjoy an arboreal life among primeval forest trees. The head of these curious creatures was prolonged into a muzzle, well furnished with sharp teeth, and their neck was long and bird-like. From the same strata are derived the fossil remains of a gigantic carnivorous Lizard allied to the Monitor, having powerful teeth with serrated edges, and which inhabited the banks of the ancient rivers. This colossal saurian (*Megalosaurus*) appears to have reached the appalling length of thirty feet. The genus *Spondylosaurus*, an extinct form allied to *Ichthyosaurus*, is from the Oolite of Moscow; two species of *Pliosaurus*, a gigantic reptile of the same family, are from the Oxford clay; the Lacertine *Geosaurus* of Cuvier is from Mannheim; and from the Oxford clay is derived *Idiochelys*, a Marsh-Tortoise of the family *Emydidæ*. There are, moreover, several genera belonging to the family *Crocodilidæ* found in different stages of the Oolite, such as the *Ælodon*, *Mystriosaurus*, *Macrospondylus*, *Gnathosaurus*, *Rachæosaurus*, *Pleurosaurus*, *Steneosaurus*, and *Pelagosaurus;* the *Pœcilopleuron*, of the same family, is from the great Oolite of Germany.

From the Oxford stage are derived fishes of the Ray tribe belonging to the genera *Asterodermus* and *Euryarthra*. From this formation, also, are procured fourteen extinct genera of *Polypteridæ*, sauroid fishes with homocercal tails, of which the *Polypterus* of the Nile and the Gambia is the living representative; lepidoid fishes with homocercal tails, belonging to the family *Lepidotidæ*, were also numerous.

Remains of Crustaceous animals have been found in the lithographic schists of Solenhofen, especially numerous genera of the family *Sphærodermidæ*, as *Alvis*, *Naranda*, *Sculda*, *Norna*, *Urda*, and *Reckur*; several genera also of the Prawn-family, *Palæmonidæ*, as *Dusa*, *Blaculla*, *Saga*, *Udora*, &c.; and of the Lobster-tribe *Astacidæ*, as *Magila*, *Orphnea*, *Brisa*, *Bolina*, *Aura*, &c., have been discovered and described by Count Munster, from the Oxford stage of Bavaria. Among Insects, the elytra of Beetles belonging to the families *Prionidæ*, *Blapsidæ*, and *Buprestidæ*, have been found. More than one hundred and thirty species of Gasteropodous *Mollusca* occur in this group, chiefly belonging to the genera *Trochus*, *Patella*, *Turbo*, *Turritella*, *Actæon*, *Melania*, *Natica*, *Rostellaria*, *Cerithium*, and *Pterocera*, which are recent, and to *Nerinæa*, *Cirrus*, *Pleurotomaria* and *Trochotoma*, which are extinct genera. The bivalve *Pholadomya*, and the extinct *Gryphæa*, known from *Ostrea* by its curved beak and flat upper valve, are found in the Oolite; in the Kimmeridge-clay the latter shells form entire layers; species are also common in the Shanklin sand of the Isle of Wight. Some Cephalopods are likewise present, especially longitudinally-striated *Nautili*; the crosier-shaped *Ancyloceras*; and the spiral *Helioceras*, with the whorls detached. Besides these, may be mentioned the curious genus *Diceras* of the Alps, *Avicula*, *Cypricardia*, the brachiopodous

Spirifer, *Atryapa*, *Orthis*, *Terebratula*, *Lingula*, and *Pentamerus*, and the cephalopodous genera *Orthoceras*, *Lituites*, and *Phragmoceras*.

In the slate of Solenhofen a few impressions resembling those of *Medusæ* are the only traces yet discovered of the evanescent, delicate, and fragile *Acalephæ*. One of the limestones of the middle Oolite is named the "coral rag," from the abundance of corals it contains; there is also a bed of coralline limestone upon the freestone of the lower Oolite of the Cotteswold Hills. These remains of Zoophytes consist chiefly of the genera of *Explanaria;* star-like *Astreæ;* fungus-shaped *Agariciæ;* flower-like *Caryophylliæ;* cup-shaped *Cyathophylla;* and many other forms of the larger lithophytes now confined to equatorial seas.

Several genera of Sponges have been identified in the Oolitic rocks, as the reticulate *Achilleum;* the turbinated *Cnemidium* and *Siphonia;* and the polypiferous genera *Catenipora*, *Porites*, *Cystiphyllum* and *Graptolithus* have also been met with.

Belonging to the World of Vegetables we find in the Oolitic epoch the elegant Thick-fern or *Pachypteris*, the Tongue-leaved Fern, *Glossopteris*, and the Round-leaved Fern, *Cyclopteris;* in the family *Cycadaceæ;* the winged leaves of *Pterophyllum*, and a species of *Zamia* have been detected; and among the *Pinaceæ*, *Peuce*, *Brachyphyllum*, *Taxites* and *Thuytes;* while in the lower Oolite of Yorkshire, a colossal Horsetail, or *Equisetum*, has been discovered.

IV.—WEALDEN GROUP.

The Wealden is a fresh-water deposit, consisting of beds of clay, argillaceous limestones, and sands, with occasional layers of lignite. It is considered to be the delta of an ancient river, containing land plants, fresh-water mollusks, fishes, tortoises, and enormous saurians.

In its geographical distribution this formation extends from Horsham to Hastings, where it dips beneath the sea, forms the bed of the English channel, and re-appears in the valley of Braye in the Department of the Boulonnois; similar strata occur in Germany and Westphalia, in the Isle of Bornholm, and at Niederschöne in Saxony.

In the Wealden formation an extinct genus belonging to the Order of Wading-Birds (*Palæornis*), and a natatorial genus, the *Cimoliornis*, also extinct, have been detected. Large terrestrial and aquatic reptiles abounded during the epoch of the Wealden, among which may be mentioned the *Iguanodon* of Mantell, a gigantic, herbivorous saurian, with serrated teeth, and which is calculated to have attained the length of thirty feet; there were also the *Hylæosaurus*, with long, bony processes arranged along the back; the *Cetiosaurus*, or Whale-Lizard, with the spongy bones of a cetaceous animal, and of the size of the largest Whales; the *Teleosaurus*, or slender-nosed Crocodile, with the tapering jaws of the Gangetic Gavial; the *Goniopholis*, or Swanage Crocodile, with angular plates on the skin; the *Succhosaurus* with biconcave, and the *Streptospondylus* with convexo-concave vertebræ. Besides these, there were several genera of Marsh Tortoises, as *Tretosternon, Eurysternon, Trionyx, Platemys* and *Emys.* The fishes of this group comprise the genera *Lepidosteus, Lepidotus* and *Hybodus.* The remains of the little entomostracous genus *Cypris* are very abundant in the Wealden of Kent, and of the Isle of Wight, their bivalve carapaces occurring in extensive layers; the crustaceous genus, *Archœoniscus,* is also from the Wealden of France and England, and numerous remains of Coleopterous, Neuropterous, Orthopterous, Dipterous, and Hemipterous insects have likewise been detected.

Among mollusca the fresh-water genera *Cyclas, Unio, Paludina,* and *Anodonta,* have been met with.

V.—CRETACEOUS GROUP.

The Chalk group comprises a series of marine deposits, composed of chalk, limestone, sandstone, marls, and clays. The lower portion, or *galt,* consists of beds of bluish or black clay, with green sand, containing hardened concretions; the upper portion, or *chalk proper,* consists of soft, white chalk, with layers of flint, and hard chalk without flint. The chalk formation composed the bed of an ancient ocean, and contains the organic remains of many marine plants and animals. It extends over portions of the British Islands, various parts of France, Germany, Denmark, Sweden, Russia, and

America. The group offers varied peculiarities in different parts of the world, as in the green-sand of England; the beds of flints of Saxony and Bohemia; the indurated chalk of Greece; the white limestone of the Mediterranean; the quadersandstein of Saxony, and the beds of sand and clay in America.

In the Chalk of Jersey, United States, a grallatorial bird of the genus *Scolopax* has been discovered; a skeleton of a bird, nearly entire has been met with in the slate of the Swiss Alps; and a bird, allied to the Albatross, in the white chalk of England. The Lizard of the Meuse, or *Mosasaurus*, a marine saurian about twenty-five feet long, with a powerful flattened tail, and intermediate in structure between the *Monitor* and *Iguana*, has been obtained from the river adjacent to the quarries of St. Peter's mountain, near Maestricht; and an allied reptile, the *Leiodon* of Owen, from the Chalk of Norfolk. From the Chalk near Cambridge, the *Raphiosaurus*, and from the green-sand of the vicinity of Hythe, the remains of a colossal reptile with fold-like markings on the teeth (the *Polyptychodon*), and a species of Pterodactyle have also been discovered. The fishy tribes of the Cretaceous group, comprise extinct cycloid genera allied to the Salmon, Carp, and Pike, and ctenoids allied to the Perch, found in the upper stages of the Chalk of England and Germany; *Osmeroides Mantellii*, and many fishes of the Shark-tribe, belonging to the genera *Squalus*, *Galeus*, and *Isurus*, are also found in this formation.

In the Molluscous Sub-Kingdom the genera of the Cephalopodous family *Ammonitidæ* were very numerous in the Chalk; among which may be noticed the straight, chambered *Baculites;* the hook-shaped *Hamites*, the discoidal, open-whorled *Crioceras*, the *Ammonites*, with the whorls discoid and united, the obliquely-whorled *Toxoceras;* the *Scaphites* with the last whorl detached, the *Ptychoceras* bent upon itself, the twisted *Anciloceras*, and the sinistral, turrited, spiral, chambered shell, the *Turrilites*. The ancient Cephalopods seem indeed to have here arrived at their maximum of development, and to have become gradually extinct. The Gasteropodous forms comprise species belonging chiefly to existing genera, as *Rostellaria, Trochus, Turbo, Vermetus, Auricula*, and *Dentalium*, and the fossil genus *Cirrus*. The bivalves consist principally of *Plagiostoma*, a fossil genus allied to *Spondylus*, with the valves beset with spines, and which is very frequent in the Chalk; the thin fibrous *Inoceramus;* the spiny *Podopsis;* and the extinct genus *Catellus* are also found; besides *Ostrea, Corbis, Thetis, Perna, Gryphæa, Trigonia*, and *Gervillia*. Pectens are also common, as is also *Rhynchonella*, one of the same family.

The Chalk-formation is most numerous in the forms of the free Echinoderms, as the fixed, pedunculated genera were more abundant in the older secondary rocks. *Spatangidæ* prevail in the lower Chalk; we find *Holaster*, and smooth *Spatangi*, and species of *Micraster* and *Ananchytes*, or Helmet

Echinite, in the upper strata. There are also found numerous species of Turban-Urchins (*Cidaridæ*), as the elegant *Hemicidaris*, and others. Species of *Clypeus*, or Buckler-Echinite, *Cyphosoma*, and *Salenia*, are also present. Among the *Crinoidea*, we find the purse-like *Marsupites*, and the Pear-Encrinite (*Apiocrinus*) from the Bradford clay of Wiltshire; also the *Pentacrinus*. A few *Asteriidæ* and *Ophiuridæ*, and a *Goniaster*, or Cushion-star, are frequent in the white chalk, besides *Conulus* and *Discoidea* of the *Cidaridæ*. Among the *Polypifera*, those funnel-shaped bodies, often termed "petrified mushrooms," occur; they belong to the genus *Ventriculites*, and are very numerous in the Chalk; *Ocellaria* is a beautiful allied genus, and, besides these, *Astreæ*, *Fungiæ*, *Meandrinæ*, and *Caryophylliæ* prevail. Many *Polyzoa* also occur, as *Eschara*, *Crisia*, and *Flustra*. The shell-like skeletons of *Foraminifera* are found in great abundance in the Chalk, thirty genera, comprising two hundred and fifty species, having been described by M. D'Orbigny. Among these may be observed the crosier-like *Lituola*, the fan-shaped *Flabellina;* the entwined and spiral *Textularia;* the globular *Xanthidium*, and the saucer-shaped *Pyxidiculum*. The whole mass of the white Chalk, moreover, has been shewn by Ehrenberg almost to consist of the skeletons of *Infusoria*, or polygastric animalcules, mixed up with well-preserved Foraminifers. The tabular and nodular masses of Chalk-flints are believed to be composed principally of fossil *Sponges*, which are often mineralized by pyrites. Among them we may notice the reticulate mass of the genus *Manon;* the branching *Scyphia;* the funnel-shaped *Chenendopora;* the turbinate *Cnemidium;* and the bulbiform *Siphonia.*

Among the few vegetable productions found in the Chalk, we may mention the liliaceous genus *Clathraria,* and *Fucoides* from the Glanconite or fire-stone.

VI. CLASS.—TERTIARY-FORMATIONS.

This class consists of an extensive series of strata, marine, lacustrine, fluviatile, and volcanic. The remains of animals and plants abound, comprising extinct and existing species of mammals, shells of the river, lake, and land, and many types altogether extinct. It comprehends all the deposits of marl, clay, sand, and gravel, which occur above the chalk. The creation of races of beings that now people the surface of the globe had its commencement in the epoch of these formations. The cities of London and Paris are built on marine and fresh-water beds, which have been deposited during this era, in the form of vast basins; the tertiary strata are found also on the coast of Africa; the shores of the Mediterranean, in the form of nummulite limestone; in Russia, on the level tract between the Baltic and the Northern Ocean; in Asia, near the Bay of Bengal; in the east of North America; and in Equatorial America; they occur, also, in the soft sandstones of the Swiss lakes; the valleys of the Danube and the Rhone; and the lacustrine sands and marls of Auvergne; and also along the southern basis of the Himmalaya.

I.—EOCENE GROUP.

This group constitutes the most ancient of the tertiary formations. It is composed of marine and fresh-water beds of blue and plastic clays, thin beds of sand, and shingle mixed with lignite, &c. Here we find about three and a half per cent. of shells which belong to types of existing species.

Several *Quadrumana* have recently been discovered in strata of this epoch; namely a *Macacus* from the eocene sand of Kyson; a tail-less monkey or Gibbon (*Hylobates*) in the South of France; several species of *Semnopitheci* in India; and a *Callithrix* in the basin of the Rio des Velhas, in Brazil. The Mammals of the tertiary formations were principally, however, ponderous vegetable-eating quadrupeds, that loved to frequent the river-banks, marshes, and borders of lakes; such were the colossal *Mastodon*, the lofty *Sivatherium*, the thick-skinned *Rhinoceros*, the amphibious *Hippopotamus*, the long-nosed *Tapir*, and the *Hog*. Among Cetaceous mammals, we here find the great-headed *Balæna*, with its laminated whale-bone, the *Ziphius* and *Balænodon*, with sharp, conical teeth, and the *Zeuglodon*, a gigantic cetacean, seventy feet in length. *Ziphodon* and *Adapis* are pachyderms from the eocene stage, as is also the singular *Chœropotamus*.

The London clay produces an extinct genus allied to the Peccary, the *Hyracotherium;* and here, likewise, occurs a species of extinct bat, belonging to the genus *Molossus*, from a bed of eocene sand in Suffolk. The extinct, carnivorous genus, *Hyœnodon*, is from the lower tertiary of the Isle of Wight; and the small, marsupial *Didelphys Colchesteri*, is from the sand at Kyson. A large mammal, related to the water-mole (*Palœospalax*) has been discovered in a lacustrine deposit at Ostend; and the *Trogontherium*, a large extinct genus, allied to the Beaver, in Russia. The Paris basin, the scene of the illustrious Cuvier's labours, has furnished numerous extinct mammalian genera. The pachydermatous *Palœotherium*, with a short proboscis, like a tapir; the *Anthracotherium*, with a still shorter nose; the *Lophiodon*, with crested teeth; and the *Anoplotherium*, with only two toes on its feet, are among his discoveries. From the quarries of Montmarle have been procured three or four species of marsupials, two or three of bats, and, among *Insectivora*, the remains of a mole; among *Carnivora*, several species of bear, seal, cat, weasel, dog, and fox; among Rodents, ten or twelve species of beaver, rat, hare, squirrel, and *Lagomys;* besides bones of the great thick-skinned *Mastodon* and *Rhinoceros;* also the horse, boar, and tapir, and the ruminant forms of the elk, stag, antelope, and ox. The same vast cemetery of organic remains has supplied us with a list of eocene birds. Fossil genera of *Raptores*, as *Haliaëtus*, *Buteo*, and *Strix;* species of the rasorial genus, *Perdix;* the grallatorial genera of *Tantalus, Scolopax,* and *Numenius,* and the natatorial *Carbo,* or Cormorant. In the eocene of Sheppey, an extinct raptorial bird, allied to the vultures (*Lithornis*), and another departed form allied to the Kingfishers (*Halcyornis*) have been discovered; and in the schists of Glarus, an extinct genus of incessorial birds, the *Pyctornis.* Among reptilian forms, nearly perfect carapaces of turtles and tortoises have been found in the eocene strata of Hampshire and the Isle of Wight; an extinct genus of serpents, *Palæophis,* has been discovered in the sand of Kyson, together with species of the fresh-water tortoises, *Emys* and *Platemys.* The fishes of this group comprise seven extinct genera of Placoids, belonging to the family of *Chimæridæ;* a single fossil *Diodon;* and several genera, mostly extinct, of the *Ostraciontidæ.* In *Mollusca,* extinct species of existing genera are very numerous in the marine deposits of the tertiary strata; two hundred and twenty fossil species of *Cerithium* alone having been identified, besides numbers of *Pleurotomia, Fusus,* and *Buccinum.* A few extinct genera also occur, as *Pileolus, Omalaxis,* and *Pleurotomaria.* But few species of *Helicidæ* have been found; only ten species of *Patella;* one *Haliotis;* about seventeen *Neritinæ;* numerous *Trochidæ;* nineteen Cowries; and many species of cones, helmet-shells, rock-shells, and tritons. Among Pteropods, a few extinct forms occur, two fossil species of *Cavolina* are found in the tertiary beds of Dax and Turin. Nearly a thousand fossil species of Bivalves have likewise been discovered in these strata, including the genera *Ostrea*, *Pecten*, *Venericardia*, *Cytherea*, *Lucina*, *Corbula*, *Tellina*, *Nucula*, *Crassatella*, &c. The fossil oysters often occur in extensive beds, as in the tertiary clays near Woolwich, and in the lowermost sands and clays of the London basin.

II.—Miocene Group.

The Miocene forms the middle group of tertiary strata; it is composed of fresh-water and estuary beds of marls, imperfect limestones, and clays.

The lower part of this formation in England, consisting of a mass of calcareous marls, shells, and small corals, is called the "Coralline Crag of Suffolk;" five hundred species of mollusks have been obtained from it. Out of England, the faluns of Touraine, the beds of Bordeaux, the conglomerate of Piedmont, and part of the molasse of Switzerland, belong to this group.

In the Falunian stage, the *Metaxytherium*, a curious extinct mammal, allied to the Lamantin and Dugong, has been found. In beds of sand and marl of this group, we see at Darmstadt in Germany the bones of one of the most gigantic mammals yet discovered, the *Dinotherium*, an animal as large as an elephant, with tusks in the lower jaw curved downwards; it is allied to the *Mastodon* and *Tapir*, and is supposed to have hung by its tusks to the banks of rivers and lakes, like the Walrus to the floating masses of ice in polar seas. Belonging to the Miocene stage are those extinct Pachyderms, the *Hyotherium*, *Macrauchenia*, and *Chalicotherium*, and four species of Rhinoceros; a solipede mammal, allied to the Horse, from Eppelsheim, the *Hippotherium;* and several species of *Trichechus* or Walrus, from the middle tertiary beds of France and England, may be alluded to. The extinct genera of digitigrade *Carnivora*, *Machairodus*, with its formidable canine teeth, and *Amyxodon*, are also from these strata, besides numerous genera of Rodents, as *Trogontherium*, *Steneofiber*, *Palæomys*, *Chalicomys*, *Archæomys*, and *Chelodus*. In the Falunian stage, Insessorial Birds of the genera *Corvus* and *Fringilla*, and the Grallatorial forms of *Ciconia*, *Scolopax*, and *Phœnicopterus*, have been identified.

Loricated polygastric animalcules are found fossil in the tertiary deposits of Europe and America, such as the simple chain-like *Bacillaria;* the elegant bivalved *Cocconeis;* the boat-shaped shields of *Navicula;* the discoid *Gaillonella;* the slender, elongated *Synedra;* the cruciform *Podosphenia*, and the toothed carapace of *Eunotia*, together with *Chætotyphla* and *Peridinium*. Many of these siliceous shields are found in the substance termed "Tripoli," and in the "Bergmehl," or fossil farina, used as food, mixed with the ground bark of trees, by the natives of Finland and Lapland.

III.—PLIOCENE GROUP.

This group forms the most recent of the tertiary formations, and is composed of beds of marl, marine shells, and gravel, and calcareous conglomerate; the organic remains consist of species generally resembling those of existing forms.

The Pliocene epoch is divided into the lower, including the red crag of Suffolk, in which phosphatized bones and coprolites occur in great abundance; and the upper, or newer Pliocene, which includes the red crag of Norfolk, in England, about half the Island of Sicily, the blue clay of the Mediterranean, and the argillaceous limestone around the Caspian.

The species of *Mollusca* of the newer Pliocene are nearly identical with the recent species, while many of the mammals belong to forms entirely lost; the species of fish of the Norfolk crag are mostly referable to genera common in tropical seas. The upper tertiary marine deposits exhibit many genera of *Polyzoa* and of polypiferous animals, such as species of *Isis*, *Madrepora*, *Eschara*, *Nullipora*, *Flustra*, *Meandrina*, *Turbinolia*, and others.

The plants of the tertiary formations consist of Ferns, *Pinaceæ* in great numbers, Palms and tropical monocotyledons, Elms, Willows, Poplars, Chesnuts, and Sycamores; *Carpinus*, *Betula*, *Comptonia*, and three species of the Walnut tribe. The chief genera of the *Pinaceæ*, are *Pinus*, *Taxites*, and *Podocarpus*, and among the family of Palms, leaves of *Flabellaria*, *Phœnicites*, and *Juniperites*, and the fruit of *Cocos* have been discovered; and, belonging to the Lily-tribe, those of *Amomocarpum* and *Pandanocarpum*. The bodies called "*Gyro-*

gonites," or fossil fruits of the genus *Chara*, with spirally twisted valves, are also common.

IV.—GLACIAL, OR POST-PLIOCENE GROUP.

This group, sometimes called the Ancient or Diluvial Drift, consists of deposits still in course of formation; beds of rivers, lakes, peat-bogs, coral limestones, volcanic ejections, and calcareous deposits from mineral springs. These results are commonly ascribed to the unusual operations of water, or by the passage of diluvial waters over the surface of the earth, thus accounting for the gravel, sand, and clay, with boulders, or rounded masses, and water-worn transported materials. What are termed "erratics" also occur in this group; they consist of large, angular masses of rock, distinct from the rounded boulders, and are now believed to have been transported by ice, and so to have preserved their angular forms: they occur only in extra-tropical regions. The scratches or grooves on the surface of rocks of this epoch are accounted for by the pebbles moving with, and immersed in, the beds of boulder-clay, which once covered the rocks; the movements being produced by landslips, and the descent of semi-fluid mud down the sides of mountains and along valleys.

In this last deposit of the tertiary formations, we find the remains of many large mammals of species both recent and extinct. *Ossiferous Sands* and *Gravel* of the valleys of Great Britain, the continent of Europe, and the river-plains of North

America, contain bones of various mammals, as Elephants and Mammoths in Siberia and the North of Europe, and the Mastodons and Megatheriums of the New World. Among Cetaceous mammals, which have been observed in *alluvial silt,* is a species of *Balænoptera,* seventy-two feet in length, embedded in clay twenty feet above the highest tide-mark at Alloa in Scotland, besides the bones of a Narwhal, a Manatee, and species of *Physeter* and *Balæna.* The remains of colossal Pachyderms are frequently found buried in superficial alluvial deposits throughout Europe. The *Mastodon,* with mammillated molar teeth, and without tusks in the adult, resembled the elephant in form. The best known fossil elephant is the Mammoth (*Elephas primogenius*). One of these huge Pachyderms was found on the banks of the Lena, nine feet high and sixteen feet long, and with large recurved tusks; the skin of this Siberian monster was not, however, naked like that of the elephants of the present day, but was covered with a shaggy woollen coat, to guard against the cold of a northern climate. The *Elephas Ganesa* of the Sevalik hills must also have been a quadruped of very formidable appearance. Among the Sivalik mountains also formerly roamed that immense Antelope-like creature the *Sivatherium,* which was furnished with a nasal proboscis, and four horns like those of a Giraffe; here also are entombed the remains of fossil Ruminants, Oxen, and a gigantic species of Camel; the *Dremotherium* allied to the *Cervidæ,* has been discovered in the sub-apennine stage of Auvergne, and a fossil genus of *Camelidæ*, the *Merycotherium*, from the glacial regions of Siberia. Besides these, we have the extinct pachydermatous genera *Potamohippus*, *Chærotherium*, and *Elasmotherium*, from the sub-apennine or newer tertiary deposits of Asia, and the *Toxodon*, from the Pampas of South America. In the vast alluvial plains of South America, colossal edentate mammals have been floated from the interior of the country in a former age, and embedded in the muddy deposits. Among these are the gigantic fossil Sloth (*Mylodon robustum*), eleven feet in length, which uprooted trees with its fore-feet, and fed upon the foliage; here are also the remains of a gigantic Armadillo (*Glyptodon clavipes*) covered with a huge, tessellated shield; and the colossal *Megatherium*, larger than a Rhinoceros, with immense hind legs, on which the monster rested while rooting up the trees with the strong claws of the fore-legs. From the Pampas of Buenos Ayres we also have the *Glossotherium*, an extinct genus allied to the Ant-eaters. Besides the huge *Glyptodon*, these plains furnish us with several other extinct Armadillo-forms, as *Chlamydotherium*, *Euryodon*, *Hoplophorus*, and *Pachytherium*. From the sub-apennine stage of the Pampas, and from the caverns of Brazil, the remains of *Platyonyx*, *Scælidotherium*, and *Sphenodon*, of the family *Megatheriidæ*, are collected. The fossil Rodent *Lonchophorus*, and the *Leptotherium*, an extinct genus of *Bovidæ*, are also from the same locality.

The remains of fossil birds are also very numerous in these post-pliocene deposits. In the subapennine stage of Auvergne, a raptorial vulturine genus, *Cathartes*, and the natatorial forms of *Carbo*, *Anas*, and *Mergus*, have been discovered. From the diluvium of New Zealand colossal skeletons have been procured of an extinct genus of Cursorial birds, intermediate in structure between the *Apteryx* and the Cassowary, the *Dinornis*, one species of which must have stood twelve feet high; *Notornis*, an extinct genus allied to *Porphyrio*, and the fossil remains of a large and curious parrot related to the genus *Nestor*, have also been found. From Madagascar an extinct genus named *Epyornis*, of even vaster dimensions than the *Dinornis*, and belonging also to the Cursorial Order, has been lately discovered, together with the remains of its eggs; and from the Mauritius and the Isle of Rodriguez, enormous extinct species of Columbine birds (the *Didus ineptus* or Dodo), allied to the recent genus *Geophaps*, have been made known to us by remains of comparatively recent date.

The Reptilian tribes are here represented by extinct species of recent genera of Ophidians, Batrachians, *Crocodilidæ* and *Lacertidæ*. In the newer tertiary bed of the Himalaya, fragments of an enormous fossil tortoise (*Megalochelys*) have been discovered, justifying the inference that the carapace must have been twenty feet in length. In the sub-apennine stage of Œningen, the famous fossil skeleton of Andreas Scheuchzer, a reptile of the family *Salamandridæ*, was found, and which its discoverer mistook for a human skeleton; in the same strata the *Palæophilus*, an extinct genus of the *Ranidæ*, or Frogs, is found; and near Bonn, the *Palæobatrachus*, belonging to the same family. The Paris beds contain an extinct species of *Pristis* or Saw-fish.

In this formation those remarkable *ossiferous caves* occur filled with the bones of mammals. Among the mud of these ancient caverns in England, France, Germany, Belgium, the coasts of the Mediterranean, in North America, and in Australia, the carnivorous Tiger, Hyæna, Bear, Wolf, Fox, and Weasel; the pachydermatous Elephant, Rhinoceros, Hippopotamus; the Horse; and the ruminant Ox, and Stag, have been exhumed. *Carnivora* are especially frequent in these bone-caves; as in Kirkdale, Kent's, and Creston Caves; in Franconia, and in parts of the Hartz. Here Bears of the size of large horses, as the *Ursus spelæus*, Hyænas, Tigers, Otters, Badgers and Polecats, are numerous. Among these are found bones of other animals either of existing species, as the Reindeer, Red-deer, Goat, Wolf, and Fox, or associated with extinct forms of the Ox, Horse, Rhinoceros, Hippopotamus, and Elephant. In Kent's cavern, a horse-shoe Bat (*Rhinolophus*) has been discovered. The fossil remains of several birds have also been found in these ossiferous caves, as the rasorial genera *Gallus*, *Phasianus*, *Numida*, and *Crypturus;* the grallatorial forms of *Otis*, *Rallus*, and *Crex;* and the natatorial *Larus*, *Anser*, and *Colymbus*, besides the raptorial *Vultur* and *Aquila*, and the insessorial *Motacilla*, *Anabates*, *Hirundo*, and *Caprimulgus*. In the caverns of Brazil remains of scansorial birds, *Coccyzus*, *Picus*, and *Psittacus*, and the cursorial *Rhea*, a bird allied to the Ostrich, have been discovered.

V. CLASS.—QUATERNARY-FORMATIONS.

In the Drift, or Superficial Accumulations, we find the present era represented; the beds of gravel, sand, coral-reefs, and peat-moss, being of recent formation, by the agency of floods, irruptions of the sea, and the action of rivers, glaciers, and icebergs. When the remains of plants and animals occur, they are found to belong to those of existing species.

I. GROUP.—ALLUVIAL DEPOSITS.

These deposits are produced by the ordinary action of water, and are formed of sand, gravel, and clay. The study of these recent or alluvial deposits, such as the extension of the deltas at the mouths of rivers; the receding or encroaching of the sea; volcanic disturbances; the mud and gravel deposited in their course by rivers and torrents, are all important, as shewing the nature of the changes on the earth's surface that occurred in ancient epochs. *Raised Beaches* are produced by the action of the sea, by depositing new matter so as gradually to increase the coasts, as in Guadaloupe, where human remains have been imbedded; or they are the results of recent earthquakes, as on the coast of Chili and at the mouth of the Indus. In the Mediterranean is a terrace or raised beach fifty feet above the level of the sea, and abounding in shells of the present date. *Submarine forests* of trees belonging to species still living, are sometimes found below the level of the sea, as on some of the coasts of Great Britain, the estuary of the Tay, and in the North of France. They owe their unusual position either to the encroachment of the sea, or to partial depression of the land *Marine Silt* comprises those recent accumulations of sand, mud, and clay, collected by the tide and waves, and altering the outline of promontaries and bays, or filling up fens and marshes. The Isthmus of Suez has by this means doubled its width since the time of Herodotus; Tyre and Sidon, once sea ports, are now several miles inland; and large districts in Holland are modern formations of the existing seas.

Submarine accumulations are formed by currents from the poles to the equator, carrying with them rocks and gravel, embedded in icebergs, which gradually form strata at the bottom of the sea. The mud, carried out by great rivers, produces the same effect as in the Yellow Sea, the Gulf of Mexico, and the Caribbean Sea. In the German Ocean enormous shoals are found, as the Dogger-bank, destined, perhaps, in future ages, to form new islands. The various *Deltas*, as those of the Ganges, Rhine, and Nile, are triangular islands, or mud-flats, formed also by alluvial deposits of mud; they gradually become larger and wider, the apex of the triangle always pointing up the rivers. *Estuary deposits* are formed by the mud, sand, and vegetable matter brought down by the rivers. The bones of animals, and plants of the interior, are often found in these deposits; as those of the Elephant and Tiger at the mouth of the Ganges; those of the Camel and Crocodile at the mouth of the Nile; those of the Hippopotamus, the Rhinoceros, and the Giraffe, at the mouth of the Niger; and those of the Buffalo and Elk at the mouth of the Mississippi. *Lacustrine deposits* are beds formed in lakes, morasses, and swamps, producing heaps of shell-marl and peat-moss, clay-slate, and rolled pebbles, with remains of fresh-water fishes. The prairies of North America, the pampas of South America, and the steppes of Europe and Asia, were, most probably, lakes, filled up by these accumulations; bones and horns of deer, horses, bears, beavers, and foxes, are found in these deposits. *Mineral deposits* constitute all aggregations of mineral and saline matter, derived from the action of springs, forming crusts of various substances, as the stalactites and stalagmites of Derbyshire, and the grotto of Antiparos. *Tufa*, or travertine, is a deposition of lime, as in cold springs, where it forms *calc-spar*, and in hot springs, where it occurs in the form of *arragonite.* These springs are often made to incrust various objects, thus producing false fossils. Hot springs, as those of Iceland and in the Azores, deposit silex on cooling, which is called *tuff* or *sinter;* opal is also formed in this manner. Ferruginous springs, as those of Sweden, deposit sesqui-oxide of iron, which is called bog or marsh iron, and, mixed with sand or gravel, forms sand-ore. In many springs, as in those of Vienna, gypsum and chloride of calcium are thrown down; several lakes of Russia also deposit a saline crust; and in Egypt, soda is likewise deposited. The turf-moors at Frauzenbad are coated with sulphate of soda, or "Glauber-salt," and sulphate of iron; and the limestone caverns of Brazil and Ceylon are incrusted with nitrate of potassa, or saltpetre. In the neighbourhood of the Dead-Sea, and in the island of Trinidad, there are springs of mineral-oil, which, on drying, become *Asphalt.*

Rivers, in passing through rocks rich in ores, often separate particles of these precious substances from their matrix, which are afterwards deposited or thrown down; as shewn in the stream-gold, tin, platinum, and magnetic-iron, found in Wicklow, the Ural Mountains, Brazil, Australia, and California. All platinum, and the greater portion of gold, is procured in this manner; as are likewise the gold of Borneo, the zircon of Bohemia, the hyacinths and chrysoberyls of Ceylon, and the diamonds of Brazil.

Turf consists of moss, marsh, and water plants, which have gradually died and become changed into a brown, combustible substance; turf-formations are extensive in Ireland, where they constitute the great bogs; and in Hanover, and at San Paulo, in the Brazils, they are likewise developed on a large scale; a kind of turf is formed on the shores of the

North-Sea, from accumulations of sea-weed. *Shell-beds* are formed of dead and drifted shells, heaped together by tides and currents; the fresh-water species producing beds of marl, and the marine forming layers of oysters, mussels, and cockles, which are often silted up and form elevated beds. *Landslips* are often recent formations, which are produced by a soft stratum being undermined by water, and the harder superjacent earth sliding down, as in the Undercliff of the Isle of Wight. Some recent deposits are almost entirely composed of polygastric animalcules, as polishing-slate, or *tripoli.* The *Polypifera* also form superficial incrustations on the inequalities of the sea-bottom, caused by lofty mountains, or banks near the surface; the labours of these small animals forming *reefs* and *atolls*, alter considerably the features of groups of islands. The circular reefs, or atolls, are founded on the summits of submerged volcanoes; the edges of the crater forming a foundation for the reef, and the crater itself constituting the central lagoon, as in the coral islands of the Dangerous Archipelago. Flat or tabular reefs are founded upon an elevated portion of sea-bottom, and form solid islands of coral. Long and narrow reefs are founded on submerged mountain-ridges, and are often of great length, as on the east coast of New Holland and in the Indian Ocean. Reefs encircling high land, and separated from it by a narrow channel, indicate a submergence of the islands they surround, as at Tahaa and Raiatea. Great masses of limestone are formed by the sea-water dissolving these coral-masses, and depositing it in a new form.

II. GROUP.—SOIL DEPOSITS.

The uppermost stratum of the earth's crust is formed of *soil*, produced by organic agency, and consists of decomposed animal and vegetable substances, with an earthy admixture.

Inorganic Soil is composed of clay, silex, or sand, with magnesia, saline and metallic compounds, as gypsum, salts of soda, and potassa, and the oxides of iron and manganese. *Organic Soils* are formed of decayed animal and vegetable matter, with chemical compounds of humus, carbon, and ammonia.

II. SECTION.—MINERALOGY.

Mineralogy treats of those substances, whether simple or compound, which exist naturally in the crust of the earth, forming collectively the rocks and strata which have been already spoken of under the head of descriptive Geology; and it accordingly describes the form, structure, composition, properties, and uses of inorganic bodies. The term itself is objectionable, being derived from a Latin and a Greek root, a more correct word being "Metallology." Its scope is, at present, tolerably extensive, as it is found convenient to include under it all inorganic natural substances, whether gaseous, liquid, or solid.

In pursuing satisfactorily this branch of enquiry, a correct knowledge of the laws of crystallography is requisite, as minerals were formerly principally classified according to their outward shape; and crystalline form is still of much importance, though not of such primary consequence. Other qualities to be particularly attended to, are lustre, colour, transparency, refraction, iridescence, polarization, phosphorescence, also specific gravity, hardness, state of aggregation, fracture, taste, odour, and especially chemical composition. Those more immediately suitable for our purpose, as generally and more easily applicable, are, 1. *Lustre,* which may be metallic, vitreous, resinous, pearly, silky, or adamantine, while the *intensity* may be splendent, shining, glistening, glimmering, or dull. 2. *Colours,* of which eight are accounted as fundamental in mineralogy, namely, white, gray, black, blue, green, yellow, red, and brown, which are termed "non-metallic" colours; others are spoken of as "metallic," which are copper-red, bronze-yellow, brass-yellow, gold-yellow, silver-white, tin-white, lead-gray, steel-gray, and iron-black: these are subdivided into shades, for each of which a natural standard has been established, which may be found in Syme's "Nomenclature of Colours," or in the more recent work of Hay. 3. *Transparency;* minerals may be transparent, sub-transparent, translucent, sub-translucent, or opaque. 4. *Hardness;* this is ascertained by comparing the resistance offered to the action of a file or knife by the mineral in question, with certain other known mineral bodies, selected as standards, and arranged in a fixed scale, which is as follows:

No. 1. *Talc.*
2. *Gypsum-Rock-Salt.*
2·5. *Foliated-Mica.*
3. *Calcareous-Spar* (any cleavable variety.)
4. *Fluor-Spar* (any cleavable variety).
5. *Apatite* (transparent variety).
5·5. *Scapolite* (crystalline variety).
6. *Felspar* (cleavable variety).
7. *Quartz* (transparent).
8. *Topaz* (transparent).
9. *Sapphire* (cleavable variety).
10. *Diamond.*

5. *State of Aggregation.* This may render them brittle, malleable, sectile, flexible, or elastic.

6. *Fracture*, may be conchoidal, uneven, even, fibrous, splintery, or hackly.

7. *Taste*, distinguishes some soluble minerals, which may be,—

1. *Astringent*, resembling Vitriol.
2. *Sweetish-Astringent*, resembling Alum.
3. *Saline*, resembling Common-Salt.
4. *Alkaline*, resembling Soda.
5. *Cooling*, resembling Saltpetre.
6. *Bitter*, resembling Epsom Salts.
7. *Sour*, resembling Sulphuric Acid.

8. *Odour*, is applicable only to a few substances, the divisions are,—

1. *Alliaceous*, like Garlic.
2. *Horse-Radish*, like the Decaying root.
3. *Sulphureous.*
4. *Bituminous.*
5. *Fetid*, like Sulphuretted-Hydrogen.
6. *Argillaceous*, like moistened clay.

The other characters, though often of great importance, can be only properly examined at home, and not being applicable for travelling purposes, need not here be more than alluded to.

Regarding the classification of minerals, great diversity of opinion has prevailed at various periods. Formerly they were, like most other natural objects, arranged almost entirely according to their external characteristics and crystalline affinities. But of late years, in this, as in other branches of natural science, internal constitution and arrangement have been allowed gradually to assume a more important part, until it has been admitted by most modern writers, that a truly natural system of classification must be entirely based on chemical composition. That this is the most correct view, according, at least, to the present amount of our knowledge, can scarcely be doubted, as by trusting to form only, substances of very opposite qualities and structure may be placed side by side; and yet there certainly is a considerable connection between external and internal properties, but exceptional cases are very numerous, and are very puzzling to the systematic mineralogist. The first general approach to an arrangement of this nature, included salts under the heads of their acids instead of their bases, thus bringing together all sulphates, nitrates, carbonates, &c., and binary compounds were placed according to their electro-negative element, making groups of sulphurets, phosphurets, &c. To a strictly chemical system there are, at present, several obstacles, some arising from the phenomena of isomorphism, others from the difficulty of selecting the essential element in compound minerals, or those containing several bases, but more especially from the complex nature of siliceous minerals, in which the acid appears to have more influence than the base in determining their general physical properties, so that in most books, even in the recent works of Dana and Ansted, they are grouped together as a distinct set. So long, however, as such classes are admitted, the system into which they enter, though possibly convenient for study or reference, must remain thus far artificial. In the following pages an attempt has been made to follow a classification strictly chemical, principally according to a scheme suggested in the last part of Professor Dana's work, in which minerals are proposed to be arranged according to the elementary bodies principally entering into their composition, salts being placed with their metallic bases. It is perfectly impossible within such a narrow compass to do more than indicate the heads of such a plan, the details requiring much working out, and possibly considerable modification. In each family a few of the chief genera are mentioned, as illustrations; those of more importance have their more striking properties alluded to; and, as chemistry must for the future be an indispensable ingredient in mineralogical analysis, the more simple and applicable general reactions of the compounds of each metal, or their action under the blow-pipe are noted; the symbols, also, of each element, as now usually understood and employed, are appended for reference, and to enable the reader more easily to understand the formulæ employed in most recent treatises on this subject.

In the following arrangement the letter H signifies hardness, and the specific gravity is denoted by sp. gr.

I. ORDER.—HYDROGENEXIDES.

Hydrogen, either pure or combined with other substances; liquid or gaseous.

1. FAMILY. — *Hydrogenides.* Characters as in Order. Occur as 1, *Pure Hydrogen;* gaseous, colourless, inflammable, sp. gr. 0·0694; escapes in volcanic districts, from coal beds and stagnant pools; 2, as *Sulphuretted Hydrogen,* or "Hydro-sulphuric acid;" gaseous, sp. gr. 1·177, smelling like rotten eggs, contained in mineral springs or issuing in volcanic vicinities; 3, as *Water:* liquid, sp. gr. 1., limpid, colourless, inodorous, tasteless when pure, or combined with various substances, as salts of sodium and magnesium in the sea, or with other compounds in mineral springs, which are variously denominated according to the temperature and the prevalent ingredient as cold or thermal,—acidulous, alkaline, saline, sulphureous, siliceous, calcareous, or chalybeate; 4, as *Hydrochloric* or *Muriatic acid,* gaseous, sp. gr. 1·284, colourless, pungent, taste acid; escaping from volcanic crevices; 5, as *Phosphuretted - Hydrogen,* gaseous, sp. gr. 1·761, odour alliaceous, taste bitter, often inflaming on coming in contact with atmospheric air, given off in churchyards and marshes, and popularly known as "Jack

wi' the Lantern," or "Will wi' the Wisp;" 6, as *Light Carburetted-Hydrogen*, gaseous, sp. gr. 0·5555, colourless, inflammable, odour empyreumetic, escaping from bituminous deposits, and known in coal-mines as "Fire-damp;" and 7, as *Olefiant-Gas*, gaseous, colourless, inflammable, giving off much smoke, often accompanying the last-named in coal-mines, and entering into the composition of "Fire-damp." *Symb.* H.

II. ORDER.—CHRYSEXIDES.

Metals of the gold series, either native or alloyed; solid.

1. FAMILY.—*Chrysides.* Minerals consisting of, or containing principally, gold. Occur 1, *native;* H. 2·5–3, sp. gr. 19·3, in quartz in metamorphic palæozoic rocks, or in resulting tertiary alluvial or diluvial drifts, especially in Hungary, the Ural mountains, in Africa at Kordofan, Senegal, and Zanzibar, in some Asiatic islands, and in Japan and China, in Australia, in Brazil, Chili, Peru, Mexico, the United States, and in California; 2, combined with *Tellurium* as "Graphic Gold;" H. 1·5–2, sp. gr. 5·73, in Transylvania; 3, in the same locality with *silver*, *antimony* and *tellurium* as "Aurotellurite," soft, sp. gr. 8; 3, as *Gold-Amalgam*, united with mercury and silver, in Columbia; 4, as *Electrum* combined with silver, in Siberia and Hungary.

A rock supposed to contain gold is tested by a portion being powdered and washed in a shallow iron pan, upon which most of the gold will subside, this process is repeated until the principal impurities are carried off, when mercury is added, which forms an amalgam with the gold; this is strained, to carry off any excess of quicksilver, and the remainder is expelled by the application of heat, leaving the pure gold. Gold is soluble only in Nitro-hydrochloric acid (*aqua regia*), from which it may be precipitated *pure* by sulphurous acid gas, and by a solution of sulphate of iron (green vitriol); as a *Sulphuret* by sulphuretted-hydrogen gas; or as *Purple of Cassius*, by solution of protochloride of tin. *Symb.* Au.

2. FAMILY.—*Platinides.* Minerals consisting of, or containing principally, Platinum. Almost always combined with other precious metals; often in gold alluvial or diluvial washings; H. 4–4·5; sp. gr. 17·3, or 21·5 when pure; resembling silver, but less lustrous; soluble in nitro-hydrochloric acid, from which a solution of chloride of ammonium (sal-ammoniac) throws down a yellow, insoluble compound. *Symb.* Pt.

3. FAMILY.—*Palladiides.* Minerals containing Palladium. This metal occurs in Brazilian platinum-ore, as small flattened grains, also in auriferous sand; H. 4·5–5; sp. gr. 11·8 *Symb.* Pd.

4. **Family.**—*Rhodiides.* Minerals containing Rhodium. Occurs in platinum-ore; extremely insoluble, brittle; sp. gr. 11. *Symb.* R.
5. **Family.** — *Rutheniides.* Minerals containing Ruthenium. Occasionally present in platinum-ore, also in "Iridosmine;" when pure, brittle; sp. gr. 8·6. *Symb.* Ru.

III. ORDER.—ARGYREXIDES.

Metals of the silver series, either native, alloyed, or in combination with other substances; solid or liquid.

1. **Family.** — *Argyrides.* Minerals consisting of, or containing chiefly, silver. Occurs 1, *native,* either massive, or in cubical or octohedral crystals, H. 2·5–3, sp. gr. when pure, 10·51; 2, in combination with *sulphur,* as "Silver Glance," H. 2–2·5, with *antimony* as "Antimonial-Silver," H. 3·5–4, or with *both* as "Miargyrite" and "Pyrargyrite," H. 2–2·5, with *bismuth* as "Bismuth-Silver," and in various other states. Found mostly in calcareous-spar or quartz veins, in gneiss and early slate rocks. Silver is soluble in nitric acid, from which hydrochloric acid, or a soluble chloride, as common salt, throws down a white insoluble chloride of silver. *Symb.* Ag.
2. **Family.**—*Hydrargyrides.* Minerals consisting of, or containing chiefly, mercury. Occurs 1, *native,* liquid, sp. gr. 13·545, in Carniola and

at Almaden in Spain; 2, united with *silver* as "Native Amalgam," brittle, H. 3–3·5, sp. gr. 14; 3, combined with *sulphur*, as "Cinnabar," its most important ore, H. 2--2·5, sp. gr. 8, in small red, six-sided prisms, massive, granular and steel-gray, or in fine red powder ("Native Vermilion"), mostly in slate rocks and also in coal formations in China and Japan, in Idria, and in Spain, in Brazil, Peru, Mexico, and California. *Symb.* Hg.

3. FAMILY.—*Kuprides.* Minerals consisting of, or containing principally, copper. Occurs 1, *native*, in amorphous masses, or octohedral crystals, H. 2·5–3, sp. gr. 8·667, in most copper mines; dissolves in nitric acid, giving off orange fumes of nitrous acid gas, the solution strikes a deep blue with ammonia; 2, as *Sulphuret*, trimetric, dark-gray, H. 2·5–3, sp. gr. 5·7, or "Copper-glance"—hexagonal, dark-blue, sp. gr. 3-8, or "Indigo Copper"—dimetric, brass-yellow, sp. gr. 4-2, or "Copper-pyrites," known from iron-pyrites by being able to be cut by a knife; 3, as *Oxide*, monometric, red, brittle, H. 3·5–4, sp. gr. 5·99, or "Red-Copper;" 4, as *Silicate*, rhombohedral, emerald-green, transparent, H. 5, sp. gr. 3·278 or "Dioptase;" 5, as *Carbonate*, H. 3·5–4, in oblique prisms, azure, transparent, brittle, sp. gr. 3-7, or "Blue-Malachite," massive, bright green, sub-translucent or opaque, sp. gr. 3-9, or "Green-Malachite;" 6, as *Sulphate*, triclinic,

blue, sub-transparent, sp. gr. 2·21, or "Blue-Vitriol," and many other less important forms. Found in Siberia, at Fahlun in Sweden, in Cornwall, in Australia, and in various parts of America. *Symb.* Cu.

4. Family. — *Ammoniides.* Minerals containing compounds of Ammonium. Occur 1, as *Oxide* or "Ammonia," in small quantities in the atmosphere, smell pungent; sp. gr. = 0·589; 2, as *Chloride* or "Sal-ammoniac," as an efflorescence; H. = 1·5–2, sp. gr. = 1·52; whitish; 3, as *Sulphate of Ammonia* or "Mascagnine," about volcanoes; 4, also as *Phosphate, Bicarbonate,* and combined with with *Phosphate of Soda* or "Salt of Phosphorus;" compounds of Ammonium volatize with heat, when triturated with moistened *Hydrate of Calcia* (lime) ammonia is given off. *Symb.* Am.

5. Family.—*Natrides.* Minerals containing compounds of Sodium. Occur 1, as *Sulphate,* or "Glauber-Salt," in right prisms, H. 1·5–2, sp. gr. 1·481, white, efflorescent, in thermal springs, &c.; 2, with *Sulphate of Lime,* as "Glauberite," in oblique prisms, H. 2·5–3, sp. gr. 2–8, gray, brittle, with rock-salt; 3, as *Nitrate,* or "Soda Nitre," rhombohedral, H. 1·5–2, sp. gr. 2·1, white, efflorescent, in Chili; 4, as *Chloride,* or "Common Salt," cubical, H. 2·5, sp. gr. 2·25, white, somewhat brittle and deliquescent, in the ocean, in some

inland seas, in brine springs, or in beds, principally in New Red-Sandstone; 5, as *Biborate*, or "Borax," in oblique prisms, H. 2–2·5, sp. gr. 1·71, grayish-blue, rather brittle, in Thibet, Peru, and Ceylon; 6, as *Carbonate*, or "Natron," the Nitre of Scripture, in rhombic octohedrons, H. 1–1·5, sp. gr. 1·423, effervesces with acids, in Egypt; and 7, as *Sesquicarbonate*, or "Trona," in rhomboid prisms, H. 2·5—3, sp. gr. 2·11, gray, translucent, in Maracaibo and at Fezzan. Salts of Soda tinge flame of a deep yellow colour. *Symb.* Na.

6. FAMILY.—*Kaliides.* Minerals containing compounds of Potassium. Occur as *Sulphate*, or "Aphthitalite," trimetric, H. 2–3, sp. gr. 1·73, whitish, translucent, on Vesuvian lava; 2, as *Nitrate*, or "Nitre," in rhombic prisms, H. 2, sp. gr. 1·93, white, sub-transparent, brittle, deflagrescent, in crusts on the earth in various places; 3, as *Chloride* or "Sylvine," cubical, H. 2, sp. gr. 2, white, vitreous, on Vesuvius. Salts of potassa colour flame violet. *Symb.* K

7. FAMILY.—*Lithiides.* Minerals containing compounds of Lithium. Occur sparingly as *Oxide* in some Siliceous minerals, as "Lepidolite," "Petalite," "Spodumene," and "Lithion-mica." Lithia and its salts give a red tinge to flame. *Symb.* Li.

IV. ORDER.—MOLIBDEXIDES.

Minerals containing metals of the lead series, in various states of combination; solid.

1. FAMILY.—*Molibdides.* Minerals containing lead, either native or in combination. Occurs 1, *native*, monometric, H. 1·5, sp. gr. 11·381; very rarely; 2, as *Sulphuret* or "Galena," monometric, H. 2·5, sp. gr. 7·5, colour and streak lead-gray, easily fused, frangible, in beds and veins in crystalline and uncrystalline rocks; 3, as *Oxide* or "Minium," pulverulent, in minute rhombic prisms; sp. gr. 4·6, in veins of galena and calamine; 4, as *Carbonate* or "Cerusite," in right rhombic prisms, H. 3–3·5, sp. gr. 6·4, lustre adamantine, colour white or gray, very brittle, in many lead mines; 5, as *Phosphate* or "Pyromorphite," in hexagonal prisms, H. 3·5–4, sp. gr. 7; colour green, yellow, or brown; lustre resinous, brittle, in veins with other lead ores; 6, also less frequently combined with *selenium, tellurium, antimony, arsenic, vanadic, chromic, molybdic,* and *tungstic acids.* Metallic lead fuses at 612°F., its soluble salts give a black precipitate with hydrosulphuric acid. *Symb.* Pb.
2. FAMILY.—*Baryides.* Minerals containing compounds of Barium. Occur 1, as *Sulphate of Baryta* or "Heavy-spar," tabular, H. 2·5–3·5, sp. gr. 4·7, white or grayish-blue, in metallic beds, or in distinct veins in secondary limestone; 2, as *Carbonate* or "Witherite," trimetric, in large masses, H. 3·5, sp. gr. 4·30, white, brittle, with lead ore, in coal formations.

Salts of baryta tinge flame yellow, sulphuric acid throws down a heavy white precipitate with those which are soluble. *Symb.* Ba.

3. FAMILY.—*Strontiides.* Minerals containing compounds of Strontium. Occur, 1, as *Sulphate of Strontia* or "Celestine," in right rhombic prisms, H. 3–3·5, sp. gr. 3·9, bluish-white, very brittle; 2, as *Carbonate* or "Strontianite," trimetric, often fibrous or granular, H. 3·5–4, sp. gr. 3·6, greenish, brittle; 3, combined with *Baryta,* as "Barystrontianite," in Orkney. Salts of strontia colour flame deep red, those which are soluble act with sulphuric acid like those of Baryta. *Symb.* Sr.

4. FAMILY.—*Calciides.* Minerals containing compounds of Calcium. Occur 1, as *Sulphate of Calcia* (lime) or "Gypsum," in right rhombic prisms, sp. gr. 2·3, H. = 1·5 – 2; when transparent it is *Selenite,* when massive *Alabaster,* when fibrous *Satin-spar,* and when anhydrous, H. = 3 – 3·5, it is *Anhydrite;* 2, as *Carbonate,* rhombohedral, sp. gr. 2·6, H. = 2·5 – 3·5, when in transparent crystals it is *Calcareous-spar* or *Iceland-spar;* when massive, *Limestone;* when compact and finely crystallized, *Marble;* when bituminous, *Stinkstone;* when earthy, *Chalk;* when projecting from the roof, or on the floor of caverns, &c., *Stalactites* or *Stalagmites;* when encrusting *Calcareous-tufa,* and when in rhombic-prisms, H. = 3 5 – 4, it is *Arragonite;* 3, as *Phosphate*

or "Apatite," hexagonal, sp. gr. 3·1, H. = 5, greenish or bluish, brittle, in crystalline rocks; 4, as *Fluoride of Calcium* or "Fluorspar," octahedral, sp. gr. 3-1, H. = 4, bright coloured, brittle, in veins intersecting gneiss, mica and clay slate, and some secondary rocks; 5, as *Silicate* combined with *magnesia*, in oblique rhombic prisms, sp. gr. 3-1, H. = 5–6; when dark coloured, it is *Hornblende;* with felspar, it is *Greenstone;* with "albite," *Diorite;* when fibrous, *Asbestus* or *Amianthus;* with very fine fibres, *Mountain-leather;* when spongy and elastic, *Mountain-cork.* Salts of calcia tinge flame brownish-red; when soluble they throw down a white precipitate with oxalate of ammonia. *Symb.* Ca.

5. FAMILY. — *Magnesiides.* Minerals containing compounds of Magnesium. Occur 1, rarely as *Oxide* or "Periclase," cubical and octohedral, sp. gr. 3-67, H = 6, grayish; 2, as *Sulphate* or "Epsomite," in four-sided prisms, sp. gr. 1·75, H. = 2-2, soluble, white, taste bitter, in mineral springs, as an efflorescence on rocks, &c.; 3, as *Carbonate* or "Magnesite," rhombohedral, sp. gr. 2-9, H. = 3-4, grayish, in magnesian rocks; 4, with *Carbonate of Calcia* as "Dolomite," or "Magnesian-limestone," rhombohedral. sp. gr. 2·9, H. = 3·5-4, generally whitish, brittle, often forming beds; 5, as *Borate* or "Boracite," hemihedral, sp. gr. 2·9, H. = 7, whitish, pyro-electric, in beds of

gypsum or salt; 6, as *Silicate*, 1, "Talc," "Steatite" or "Soapstone," generally in foliated masses, sp. gr. 2-7, H. = 1-1·5, greenish, sectile, greasy, when the texture is somewhat granular, it is "French-chalk;" 2, "Meerschaum," compact, H. = 2-2·5, grayish-white, dry and harsh, in alluvial deposits; 3, "Serpentine," trimetric, sp. gr. 2·2-2·5, H. = 3-4, greenish, sectile, often forming mountain masses; 4, combined with *Iron* as "Chrysolite," trimetric, usually in small transparent grains, sp. gr. 3·3-3·5, H. = 6·5-7, greenish yellow, in basaltic rocks. Magnesian compounds if moistened with solution of nitrate of cobalt, and heated before the blow-pipe, afford a clear rose-red colour. *Symb.* Mg.

6. FAMILY.—*Zincides.* Minerals containing compounds of Zinc. Occur 1, as *Sulphuret* or "Zinc-blende," in rhomboidal-dodecahedrons, sp. gr. 4, H. = 3·5-4, yellowish or brownish, brittle, often with Galena; 2, as *Oxide* or "Red Zinc Ore," hexagonal, in lamellar masses or grains, sp. gr. 5·4, H. = 4-4·5, red, brittle, in iron ore; 3, *Silicate* or "Electric-Calamine," trimetric, crystalline, fibrous or stalactitic, sp. gr. 3·4, H. = 4·5-5, whitish, brittle, pyroelectric, with zinc ores; 4, as *Carbonate* or "Calamine," rhombohedral, sp. gr. 4-4·4, H. = 5, grayish, brittle, effervescent, in calcareous rocks; 5, as *Sulphate* or "White-Vitriol," trimetric, in four-sided prisms, sp. gr.

2, H. = 2-2·5, white, brittle, soluble, formed by the decomposition of Zinc blende. Zinc compounds form a clear glass with borax; with soda or charcoal, they give a bluish flame; with cobalt solution, a green colour. *Symb.* Zn.

7. FAMILY.—*Cadmiides.* Minerals containing compounds of Cadmium, 1, as *Sulphuret* or "Greenockite," hexagonal, sp. gr. 4·8, H. = 3-3·5, yellowish, nearly transparent, rare, in porphyritic trap; 2, as *Oxide,* with many ores of zinc. Compounds of Cadmium, when heated on charcoal, deposit a reddish-brown powder. *Symb.* Cd.

8. FAMILY.—*Nickelides.* Minerals containing compounds of Nickel. Occur 1, as *Sulphuret* or "Millerite," rhombohedral, sp. gr. 5–4, H. = 3–3·5, brass-yellow, brittle; 2, as *Arseniuret* or "Arsenical-Nickel," hexagonal, metallic, sp. gr. 7–4, H. = 5–5·5, reddish, brittle, with various metallic ores; 3, as *Arseniate* or "Nickel-Ochre," pulverulent, soft, apple-green, with Copper-Nickel; 4, with *Sulphur* and *Arsenic,* as "Nickel-glance," hemihedral, compact or lamellar, sp. gr. 6, H. = 5–5, whitish, with galena, quartz, &c.; 5, with *Sulphur* and *Bismuth,* or "Bismuth-Nickel," in octohedrons and cubes, sp. gr. 5, H. = 4–5, grayish, brittle, with quartz and copper pyrites. Oxide of Nickel forms a clear, yellowish glass with borax, becoming blue on

the addition of nitre; solutions of its salts are green. *Symb.* Ni.

9. FAMILY.—*Cobaltides.* Minerals containing compounds of Cobalt. Occur 1, as *Sulphuret*, or "Syepoorite," massive, sp. gr. 5–4, yellowish steel-gray, with magnetic pyrites at Syepoor; 2, with *Sulphur* and *Arsenic*, or "Cobaltiglance," hemihedral, sp. gr. 6–29, H. = 5·5, metallic, reddish, brittle, often with copper pyrites; 3, as *Arseniate*, or "Cobalt-bloom," in oblique prisms, or botryoidal and fibrous, sp. gr. 2·9, H. = 2–2·5, reddish, sectile, with other cobalt ores. Oxide of cobalt forms with borax a deep blue glass; solutions of the salts are bright red, when anhydrous they are blue. *Symb.* Co.

10. FAMILY. — *Manganides.* Minerals containing compounds of Manganese. Occur, 1, rarely as *Sulphuret* or *Arseniuret* 2, as *Oxide*, 1, *Anhydrous peroxide* or "Pyrolusite," trimetric, sp. g. 4-8, H. = 2–2·5, blackish, metallic; 2, *Sesquioxide* or "Hausmannite," dimetric, sp. gr. 4·7, H. = 5-5·5, sub-metallic, brownish-black; 3, *Hydrated Sesquioxide* or "Manganite," trimetric, sp. gr. 4·3, H. = 4, iron-black, sub-metallic; 3, combined with *Baryta* or "Psilomelane," massive and botryoidal, sp. gr. 4·4, H. = 5-6, sub-metallic, brownish-black; 4, with *iron*, *cobalt*, or *copper*, as "Wad," "Earthy Cobalt," or "Cupreous-Manganese," amorphous, sp. gr. 3 – 3·7,

H. = 0·5-3·5, dull black; 5, also as *Silicate, Carbonate*, or *Phosphate.* Manganese compounds form with borax in the outer flame of the blow-pipe a clear violet-red glass, which becomes colourless on being exposed to the inner flame; with soda or platinum, the oxide gives a green colour. *Symb.* Mn.

11. FAMILY.—*Siderides.* Minerals containing iron or its compounds. Occur, 1, *native*, monometric, sp. gr. 7·3-7·8, H. = 4·5, ductile, magnetic, rarely in veins, more frequently in masses of meteoric origin on the surface; 2, as *Sulphuret*, 1, *Cubic-pyrites*, monometric, cubical, sp. gr. 4·8–5, H. = 6-6·5, bronze-yellow, brittle, strikes fire with steel, in rocks of all ages; 2, *White iron-pyrites*, trimetric, in tabular crystals, sp. gr. 4·6-4·8, H. = 6-6·5, pale-yellow, brittle, in coal formations; 3, *Magnetic-pyrites*, hexagonal, sp. gr. 4·4-4·7, H. = 3·5-4·5, reddish-bronze, brittle, magnetic, in fissures of crystalline rocks; 3, as *Arseniuret* or "Arsenical-pyrites," in rhombic prisms, sp. gr. 6·1, H. = 5·5-6, metallic, white, brittle, in crystalline rocks; 4, as *Oxide*, 1, *Peroxide*, "Specular-Iron" or "Red-Hæmatite," rhombohedral, sp. gr. 4·5–5·3, H. = 5·5–6·5, metallic or earthy, steel-gray or red, in crystalline or secondary rocks; 2, *Hydrous-peroxide* or "Brown-Hæmatite," stalactitic and botryoidal, or mammillary, or massive and earthy, sp. gr. 3·6-4, H. = 5-5·5, sub-metallic

or earthy, brown, in crystalline and secondary rocks; 3, "Magnetic Iron Ore," octahedral or dodecahedral, sp. gr. 4·9-5·2, H. = 5·5–6·5, metallic or sub-metallic, iron-black, magnetic; 5, as *Chromate*, in octohedrons, sp. gr. 4-3, H. = 5·5, sub-metallic, brown, sometimes magnetic, in serpentine; 6, with *Silica*, *Magnesia* and *Alumina*, as "Green-Earth;" 7, as *Carbonate* or "Spathic-Iron," rhombohedral, sp. gr. 3·7, H. = 3·5-4·5, grayish, brittle, in gneiss, mica and clay-slate, and in coal strata; 8, as *Sulphate* or "Green Vitriol," in oblique rhombic prisms, sp. gr. 1·8, H. = 2, green, soluble, taste inky, from decomposition of "Iron-pyrites;" 9, as *Phosphate* or "Vivianite," in oblique prisms, sp. gr. 2-6, H. = 1·5-2, blue or green, sectile. Salts of protoxide of iron give a bluish-white precipitate with solution of ferrocyanide of potassium (prussiate of potassa), and a deep blue with the ferricyanide (red prussiate of potassa); salts of the peroxide give a deep blue precipitate with the ferrocyanide; with borax iron salts form a dark red glass in the oxidizing flame, becoming yellow in the reducing flame. *Symb.* Fe.

10. FAMILY. — *Chromiides.* Minerals containing compounds of chromium. Occur 1, as *Sulphuret* or "Shepardite," in meteoric stones, prismatic, H. = 4, brownish-black; 2, as *Hydrous-Silicate* or "Wolckonskoite," amorphous, greenish, resinous, fragile; 3, with

silica and *alumina* as "Chrome ochre," clayey, greenish. Oxide of chromium colours the emerald, and a variety of chrysoberl. Chromic solutions are green or violet, with borax a green glass is formed, becoming of a deeper shade when cool. *Symb.* Cr.

11. FAMILY.—*Stypteriides.* Minerals containing compounds of Aluminium. Occur 1, as *Oxide*, "Sapphire," "Corundum," or "Emery," rhombohedral, sometimes massive, sp. gr. 4, H. = 9, colour various, in crystalline rocks, river beds, &c.; 2, as *Hydrous-oxide* or "Diaspore," trimetric, sp. gr. 3·4, H. = 6–6·5; grayish, very brittle; 3, as *Sulphate*, in combination with sulphates of other metals, usually of potassa, soda, or magnesia, "Native alum," octahedral, soluble, astringent; 4, as *Phosphate*, with silica, calcia, copper, &c., or "Turquois," reniform, stalactitic or encrusting, sp. gr. 2·6–2·8, H. = 6, bluish-green, in Persia; 5, as *Hydrous-Silicate* in numerous forms, as "Collyrite," "Halloysite," "Allophane," "Pinite," or combined with an alkali, as the "Zeolites," which swell before the blowpipe; 6, as *Anhydrous-silicates*, also various, as "Kyanite," "Andulusite;" with an *alkali*, forming the Felspars which occur in granite, gneiss, mica-slate, porphyry, pumice, basalt, obsidian, &c.; with *silicates of calcia, oxides of iron* and *manganese*, dodecahedral, or "Garnet," sp. gr. 3·5–4·3, H. = 6·5–7·5,

colour various, in rhombic or hexagonal scales or plates, or "Mica;" 7, *with silica, boracic acid,* and *various bases* or "Tourmaline," rhombohedral, sp. gr. 3—3·3, H. = 7—7·5, generally dark-coloured, pyro-electric, in primary rocks; 8, as *Fluosilieate* or "Topaz" in right rhombic prisms, sp. gr. 3·4—3·6, H. = 8, yellow or blue, in cavities and veins of granite rocks; 9, with *silica, sulphuric acid, soda, calcia* and *oxide of iron,* or "Lapis lazuli," or when powdered, "Ultramarine," in dodecahedrons, sp. gr. 2·3—2·4, H. = 5·5, in granite or crystalline limestone; 10, with *magnesia* or "Spinel," octahedral, sp. gr. 3·5—4·9, H. = 8, colour shades of red, among granitic and micaceous debris. Alumina forms the chief part of all clays, and is the basis of the manufacture of porcelain. Compounds of alumina, if heated to redness before the blowpipe, then moistened with solution of protonitrate of cobalt, and again strongly heated, yield a sky-blue unfused mass, the colour becoming more distinct on cooling, and appearing violet by candle-light. *Symb.* Al.

12. FAMILY.—*Glucinides.* Minerals containing compounds of Glucinum. Occur 1, as *Silicate,* coloured with *oxide of chromium* or "Emerald," or with *oxide of iron* or "Beryl," in hexagonal prisms, sp. gr. 2·7, H. = 7·5—8, green or blue, brittle, in dolomite, granite

and gneiss rocks; 2, *with alumina* or "Chrysoberyl," in right rectangular prisms, sp. gr. 3·5—3·8, H. = 8·5, yellowish-green, in alluvial fluviatile deposits in Brazil and Ceylon. Glucina is precipitated from its salts by pure potassa or soda; it is soluble in a cold solution of sesqui-carbonate of ammonia. *Symb.* G., sometimes Be.

13. FAMILY. — *Zirconiides.* Minerals containing compounds of Zirconium. Occur 1, as *Silicate*, or "Zircon" or "Hyacinth," in square prisms, sp. gr. 4·5—4·7, H. = 7·5, red, brown, yellow, or gray, in fluviatile sand and alluvial deposits in Ceylon, also in Syenite. Zirconia is precipitated from solutions of its salts as an insoluble sub-sulphate on being boiled with sulphate of potassa. *Symb.* Zr.

14. FAMILY.—*Noriides.* Minerals containing compounds of Norium. *Symb.* Nr.

15. FAMILY.—*Yttriides.* Minerals containing compounds of Yttrium. Occur 1, as *Silicate*, or "Gadolinite," monoclinic, sp. gr. 4—4·5, H. =6·5—7, blackish, in Sweden; 2, as "Tantalate" or "Yttrotantalite," not crystalline, brownish-black, sp. gr. 5·3—5·8, H. = 4·5—5·5. Yttria is precipitated from solutions of its salts by ferrocyanide of potassium. *Symb.* Y.

16. FAMILY.—*Erbiides.* Minerals containing compounds of Erbium. *Symb.* Eb.

17. FAMILY.—*Terbiides.* Minerals containing compounds of Terbium. *Symb.* Tb.

18. **Family.** — *Didymiides.* Minerals containing compounds of Didymium. Occurs with *cerium* in "Parisite," also in "Tschewkinite." *Symb.* D.
19. **Family.**—*Lanthaniides.* Minerals containing compounds of Lanthanium. Occur as *Carbonate* or "Lanthanite," in thin 4-sided plates, H. =2·5–3, grayish, coating "cerite" in Sweden; also in "Cerium-ochre," in "Monazite," and in "Mosandrite." *Symb.* La.
20. **Family.**—*Ceriides.* Minerals containing compounds of Cerium. Occur 1, as *Silicate* or "Cerite," in short 6-sided prisms, H. =5·5; sp. gr. 4·9; also in "Gadolinite," "Mosandrite," "Muromontile," &c. *Symb.* Ce.

V. ORDER.—URANEXIDES.

Minerals containing metals of the Uranium series, either native or in different states of composition; solid.

1. **Family.**—*Uraniides.* Minerals containing compounds of Uranium. Occur 1, as *Oxide*, or "Pitch-blende," octahedral, H. = 5·5, sp. gr. = 6·7, black; also in "Urinite," "Medjidite," "Liebigite," &c. Compounds of the peroxide afford permanent yellow colours. *Symb.* U.
2. **Family.** — *Columbiides.* Minerals containing compounds of Columbium. Occur 1, as *Columbic acid,* with Yttrium in "Yttro-tantalite," H. = 4·5—5·5, greenish-black, or with

iron in "Ferro-tantalite," H. 5—6; sp. gr. = 7·5; black, brittle. *Symb.* Ta.

3. FAMILY.—*Niobiides.* Minerals containing compounds of Niobium. Occur as *Niobic acid* in "Polycrase," also in "Niobite." *Symb.* Nb.
4. FAMILY.—*Pelopiides.* Minerals containing compounds of Pelopium. Occur as *Pelopic acid* in "Polycrase," also in "Columbite." *Symb.* Pp.
5. FAMILY.—*Ilmeniides.* Minerals containing compounds of Ilmenium. Supposed to exist in "Samarskite." *Symb.* Il.
6. FAMILY.—*Kassiterides.* Minerals containing Tin, either native, or in combination. Occur 1, *pure* or "Native Tin," in grains with Siberian gold, sp. gr. 7·2—; 2, as *Binoxide* or "Cassiterite" or "Tin Ore," H. = 6·5, sp. gr. = 6·8, crystallised, massive, or in grains, brown or black; 3, as *Sulphuret* or "Tin-pyrites," in cubes, H.—4; sp. gr.—4·4, steel-gray. Oxide of tin before the blowpipe, with soda, yields metallic tin, and with borax an opal white enamel. *Symb.* Sn.
7. FAMILY.—*Titaniides.* Minerals containing Titanium, either native or in combination. Occur 1, *pure* as "Native Titanium," in copper-red cubes, in Cornwall, H. = 7, sp. gr. = 5·3; 2, as *Titanic acid* or "Rutile," prismatic, H. = 6, sp. gr. = 4·2, reddish brown, also combined with *oxide* of *iron* or some other

bases. Titanic acid if fused with an alkali is soluble in dilute hydrochloric acid, in which a solution of gall-nuts causes an orange red colour. *Symb.* Ti.

8. **Family.** — *Tungstenides.* Minerals containing principally compounds of Tungsten. Occur 1, as *Oxide* or "Tungstic acid," with iron and manganese as "Wolfram," trimetric, H. = 5, sp. gr. = 7·3, dark brown; 2, with *calcia* (lime) as "Scheelite," in square octahedrons, H. = 4·5, sp. gr. = 6, white. Wolfram readily fuses before the blowpipe into a magnetic globule studded with crystalline points. *Symb.* W.

9. **Family.**—*Molybdenides.* Minerals principally composed of compounds of Molybdenum. Occur 1, as *Oxide* or "Molybdic-ochre," an earthy yellow powder, yielding a yellow glass with Microcosmic salt; 2, as *Molybdic-acid* with *lead* or "Wulfenite," in square octohedrons, or very short prisms, H. = 2·8, sp. gr. = 6·5, yellow; 3, as *bisulphuret* or "Molybdena," hexagonal, H. = 1—1·5, sp. gr. = 4·5, feel unctuous, lustre metallic, lead-gray. *Symb.* Mo.

VI. ORDER.—IRIDEXIDES.

Minerals containing metals of the Iridium series.

1. **Family.**—*Iridiides.* Minerals containing Iridium. Occur 1, alloyed with *Osmium* as "Iridosmine," H. = 6-7, sp. gr. = 19-21,

light steel-gray; 2, with *Platinum* as "Platin-Iridium," in small grains, sp. gr. = 16-17, white. Fusible only before the oxy-hydrogen blowpipe. Solutions of its salts present varied colours. *Symb.* Ir.

2. FAMILY.—*Osmiides.* Minerals containing Osmium. Occur with ores of *Iridium*, and *Platinum*, sp. gr. = 7. Fusible before the oxy-hydrogen blowpipe. Forms with oxygen a volatile acid, with a pungent smell resembling that of chlorine. *Symb.* Os.

3. FAMILY.—*Vanadiides.* Minerals containing compounds of Vanadium. Occur as *Vanadic acid* combined, 1, with *lead* or "Vanadinite," hexagonal, H. = 2·5—3, sp. gr. = 6·9, brownish-yellow; 2, combined with *iron* or with *copper*. Dissolves in Nitro-hydrochloric acid; forms coloured solutions. *Symb.* V.

4. FAMILY. — *Telluriides.* Minerals containing Tellurium, either native or in combination. Occur 1, *pure* as "Native Tellurium," lamellar or granular, H. = 2—2·5, sp. gr. = 6·2, white; 2, in combination with other metals as *gold* or "Graphic Tellurium," prismatic, H. = 1·5–2, sp. gr. 5·7—8·2, gray; also with *bismuth*, *silver*, and *lead*. Tellurium volatizes before the blowpipe, emitting no odour. *Symb.* Te.

5. FAMILY. — *Bismuthides.* Minerals containing Bismuth either native or variously combined. Occur 1, *pure* or "Native Bismuth," rhombohedral, H. = 2—2·5, sp. gr. = 9·7, reddish-

white; 2, as *oxide* with *carbonate of iron* or "Bismuth-ochre;" 3, as *Sulphuret* or "Bismuth-glance," in acicular crystals, H. 2—2·5, sp. gr. 6·5, grayish, fusible in the flame of a candle; 4, as *Silicate* or "Bismuth-blende." Compounds of bismuth with carbonate of soda under the *reducing* flame of the blowpipe yield brittle grains of bismuth. *Symb.* Bi.

6. **Family.** — *Stimmiides.* Minerals containing Antimony either native or in combination. Occur 1, *pure* as "Native Antimony," rhombohedral, H. = 3—3·5, sp. gr. = 6·7, silver-white; 2, as *oxide* or "White Antimony," in small lamellar masses, H. = 2·5—3, sp. gr. = 5·5, fuses in the flame of a candle; 3, as *Sulphuret* or "Antimony-glance, in rhombic or six-sided prisms, H. = 2, sp. gr. = 4·5, lead-gray, volatizes before the blowpipe; 3, as *oxide* and *Sulphuret* combined, or "Red Antimony" (Kermes mineral), in red acicular crystals, H. = 1—1·5, sp. gr. 4·5, fuses on charcoal; also with *silver*, *lead*, and *arsenic*. Compounds of antimony with carbonate of soda before the *reducing* flame of the blowpipe yield metallic globules, which at the same time volatize. *Symb.* Sb.

7. **Family.** — *Arsenicides.* Minerals containing Arsenic, either native or in combination. Occur 1, *pure* or "Native Arsenic," rhombohedral, H. = 3·5, sp. gr. = 5·7, tin-white, 2, as *oxide* or "Arsenious acid," in powder or

small compact masses, H. 1·5, sp. gr. 3·7, white; 3, as *Sulphuret* or "Realgar," in small granular masses, H. = 1·5—2, sp. gr. = 3·7, red,—also "Orpiment," in lamellar masses, H. = 1·5—2, sp. gr. 3·4, lemon-yellow. Arsenical compounds before the blowpipe give off a very peculiar odour resembling garlic. *Symb.* As.

8. FAMILY. — *Phosphorides.* Minerals containing compounds of Phosphorus. Occurs combined with metals forming "Phosphurets," or as *Phosphoric acid* with metallic oxides forming phosphates, as "Phosphate of Calcia," or "Apatite," also phosphates of magnesia, alumina, iron, lead, copper, &c. *Symb.* P.

9. FAMILY. — *Nitrogenides.* Mineral substances containing nitrogen. Occurs 1, *pure* in the waters of many springs, as at Bath, Cheltenham, &c., also given off from the soil in some districts in the United States; 2, combined with *oxygen* as "Nitric acid," forming with bases "Nitrates;" 3, *mechanically mixed with oxygen,* forming atmospheric air, gaseous, colourless, inodorous, sp. gr. = ·9722, other characters principally negative. *Symb.* N.

VII. ORDER.—ANTHRAKEXIDES.

Minerals containing elementary substances of the carbon series.

1. FAMILY.—*Anthrakides.* Minerals composed of, or containing, Carbon. Occur 1, *pure* as 1,

Diamond, octahedral or dodecahedral, H.= 10, sp. gr.=3·5, white, or at times variously tinted; found in beds of streams, with sand and quartz pebbles, often with gold and platinum; 2, *Mineral coal*, H.=1—2·5, sp. gr. = 1·2—1·75, black or brown, opaque, brittle or sectile; sometimes with a small proportion of silica, alumina, oxide of iron, or bitumen; divided into bituminous and non-bituminous, the forming being the more abundant and valuable, comprising all the commercial varieties; 3, as *Carbonate of Iron* or "Graphite," or "Black Lead," hexagonal, H. 1—2, sp. gr. 2—2·3, dark steel-gray, sectile, greasy, soils paper, in gneiss, mica-slate, and primitive-limestone; 4, *combined with oxygen* or "Carbonic acid," sp. gr. 1·524, contained in many springs, and evolved from some volcanoes; also with bases forming "Carbonates." *Symb.* C.

2. FAMILY.—*Halicides.* Minerals containing compounds of Silicon. Occur 1, *with oxygen* as "Silica," rhombohedral, H.=7, sp. gr.= 2·6, forms three varieties, 1, the *vitreous* or "Quartz," or "Rock-crystal," when tinted purple by oxide of iron, it is "Amethyst," when smoky-brown it is "Cairngorm-stone;" 2, the *sub-vitreous*, or "Chalcedony," or "Flint," when coloured with oxide of iron it is "Carnelian," when variegated, "Agate," or "Onyx;" 3, the *dull*, or "Jasper," when

green with minute red spots it is "Bloodstone;" silica is held in solution by the hot waters of the Geysers; quartz is distinguished by its hardness, infusibility, insolubility, and uncleavability; 2, as *Hydrate*, or "Opal," amorphous, H. = 5·5—6·5, sp. gr. = 2—2·21, variously tinted, frequently *opalescent;* 3, as *Silicic acid*, united with bases, forming "Silicates." *Symb.* Si.

3. FAMILY.—*Boronides.* Minerals containing compounds of Boron. Occur 1, with *oxygen* as "Boracic acid," in yellowish, pearly scales; H. = 1; sp. gr. = 1·48; whitish; 2, united with bases forming borates. Boracic acid and borates, tinge flame green. *Symb.* B.

VIII. ORDER.—OXYGENEXIDES.

Minerals containing elementary substances of the oxygen series.

1. FAMILY.—*Oxygenides.* Minerals containing principally compounds of oxygen. This the most abundant element in nature seldom, if ever, occurs pure. It unites with all the other elementary bodies, except *Fluorine*, forming oxides, which act the part of bases; mechanically mixed with *Nitrogen* it is atmospheric air, of which it composes one-fifth; with *Hydrogen* it forms water sp. gr. = 1·1026, colourless, supports combustion. *Symb.* O.

2. FAMILY.—*Theionides.* Minerals containing Sulphur, either pure, or in combination. Occur

1, *pure* or "Native Sulphur," massive, or in acute octahedral crystals, H. = 1·5—2 5, sp. gr. = 2·072, yellow, lustre resinous, brittle, found in volcanic regions, also in beds of gypsum; 2, as *binoxide* or "Sulphurous acid," gaseous, colourless, sp. gr. 2·222, destroys colour, evolved from active volcanoes; 3, as *hydrated teroxide* or "Sulphuric acid," liquid, colourless, extremely acid, sp. gr. 1·85—1·86, occurs in a diluted state in some volcanic districts. *Symb.* S.

3. FAMILY.—*Seleniides.* Minerals containing Selenium or its compounds. Occurs *native* in submetallic incrustations, grayish- or brownish-black, sp. gr. = 4–3, with metals it forms "Seleniurets." Compounds of this metalloid when heated, give off an odour resembling that of horse-radish. *Symb.* Se.

4. FAMILY. — *Fluoriniides.* Minerals containing chiefly compounds of Fluorine. Occur in combination with metals forming "Fluorides." *Symb.* F.

5. FAMILY. — *Chloriniides.* Minerals containing principally compounds of Chlorine. Occur with *Hydrogen* as "Hydrochloric acid," or with *metals* forming chlorides. *Symb.* Cl.

6. FAMILY.—*Brominiides.* Mineral substances containing principally compounds of Bromine. Occur with *metals* as "Bromides," in various waters, as in the Dead Sea, and in salt water. *Symb.* Br.

7. FAMILY.—*Iodiniides.* Mineral substances containing mostly compounds of Iodine. Occur combined with *metals* as "Iodides," in some springs, but especially in the sea. *Symb.* I.

IX. ORDER.—RHETINEXIDES.

Resins and other organic compounds.

1. FAMILY—*Asphaltides.* Mineral substances principally composed of bituminous compounds, contain Carbon and Hydrogen. Occur as Bitumen, Naptha, Petroleum, Asphalte, Mineral Oil, &c., issuing from rocks in coal formations, also in lakes, and on the shores of the Dead Sea.
2. FAMILY.—*Electrides.* Mineral substances principally composed of resinous compounds, contain Carbon, Hydrogen, and Oxygen. Occur as Amber, Retinite, Fossil-copal, Mountain-tallow, Mellite, &c.

PART IV.

DIRECTIONS FOR COLLECTING AND PRESERVING OBJECTS OF NATURAL HISTORY.

I. ZOOLOGY.

The following suggestions are offered with the view of affording to collectors and others, an insight into the different methods which may be adopted for procuring and preserving the various forms of animals which will probably be met with during their wanderings; as although, at times, good specimens have been obtained unexpectedly, or almost accidentally, yet a systematic plan of procedure will, undoubtedly, better reward the labours of the Naturalist, augment the chances of the traveller, and aid in securing to science valuable materials to be used in the elucidation of that great and marvellous scheme which Omnipotence and Omniscience have designed.

The equipment of a travelling naturalist should consist of,—

1st.—A rifle, a double-barrelled and a small single-barrelled gun, with spare nipples, &c., a good supply of percussion caps, the best powder in canisters, shot of different sizes (dust-shot, Nos. 8, 6, 4, 1, and swan-shot will prove most serviceable), some of Elley's wire cartridges, and balls for the rifle.

2nd.—An ordinary dissecting case will be found to contain the instruments necessary for the usual purposes of the collector, for skinning, &c.; in addition to which, one or two larger and stronger knives, similar to butchers' knives, will be required for large quadrupeds; or, to mention the contents in detail, three or four scalpels, of different sizes; a good strong knife for cleaning the heads of the larger quadrupeds, &c.; three pairs of scissors, a moderately small short-bladed pair, a larger and stronger pair, and a pair with long blades; two chain hooks, which will be found useful in skinning some specimens; two forceps, a pair of round pliars, a pair of barber's curling-tongs for stripping the tails of quadrupeds (the mode of using which will be mentioned hereafter); one or two long quills to be cut as scoops, or one made of metal for removing the brains of animals; the large knives previously mentioned; a small hatchet, and a hone and strap for sharpening instruments.

3rd.—Preservative preparations compounded in the following manner, viz.:—

No. 1. Take of	Prepared Chalk . .	3 lb.
	Tannic acid (Tannin) .	2 oz.
	Corrosive sublimate and Camphor, of each .	8 oz.

These are to be well mixed together in a mortar, and then kept in glass bottles until required for use.

No. 2. A solution of corrosive sublimate in alcohol, in the proportion of a teaspoonful of the former to a pint of the latter, is also very good when employed as a preservative for skins, and is particularly useful for applying to the bills, the bare skin about the head, and the feet of birds. Or,

No. 3. Arsenical-paste, made thus:—

Take of	Camphor	3 oz.
	Powdered Arsenic	1 lb.
	White Soap	1 lb.
	Carbonate of Potassa	6 oz.

The soap should be cut into thin slices, put into an earthen crock, with a small quantity of water, placed over a gentle fire, and frequently agitated; when it is dissolved add the carbonate of potassa, then remove the vessel from the fire and add the arsenic, at the same time stirring the whole, and lastly mix the camphor, previously well pounded, with the other ingredients. The paste should be of good consistence, and may be preserved in tin boxes for future use.

The first preservative is that which we should use and would recommend.

4th.—A quantity of plaster of Paris should be provided for applying to stains and blood-spots on the plumage of birds.

5th.—A canvas knapsack.

6th.—Store- and pocket-boxes lined with cork for insects. The boxes made by Mr. Robert Downie, will be found as good as any. A number of these —say eight—might be placed in a strong outer case, the corners of which should be strengthened with iron clamps, and the lid grooved to receive a fillet from the lower part, made for additional protection, and partitioned into spaces for the store-boxes to slide into. These cases should not be made inconveniently large, as it would be better to have two or more of them of moderate dimensions, that they may be perfectly portable.

7th.—A plentiful supply of solid-headed pins, of all sizes, for insects, &c.

8th.—Nets and other implements for the capture of insects. The simplest is the hoop-net, consisting of a ring of strong wire, with a socket to fit on the end of a rod, which latter might, with advantage, have an additional piece provided with a socket, or a screw-ferrule, if preferred, to enable the collector to use a longer or shorter handle, as required. Three or more hoops, ten inches or a foot in diameter, might be adapted to the same rod, one hoop to have a bag-net of gauze twenty inches deep for catching insects on the wing, particularly *Lepidoptera;* another of cheese-cloth, fourteen inches deep, for sweeping, and for *Coleoptera;* a third of muslin, of the same or even less depth, for obtaining aquatic insects; and a fourth of fine net, to be used as a kind of landing-net in seeking for water insects, small fish, and crustaceans. The same rod might serve as a handle for the scoop and nets requisite for obtaining shells from the bottoms of pools and streams.

The *fly-net* is another much used, and is perhaps the best for some purposes, particularly "*mothing.*" In form it resembles that used by bat-fowlers, and is composed of two light slender rods, five or six feet long, bent at the top, and connected by a piece of leather, which serves as a hinge; on this frame-work is placed a net of gauze (green is perhaps the best colour) which extends to within about six inches of the lower extremity, and falls in a bag, to prevent the escape of any insect folded in it.

Another instrument, the *forceps*, will prove very useful, particularly for the capture of *Hymenoptera*. The handles are somewhat like those of curling-irons, having at their tips a frame, which should be of brass; over the frame is fastened a piece of gauze, strained tight, and round the rim should be sewn a piece of calico, or thin leather, as a protection to the gauze. A supply of gauze should be provided, to re-cover the frames when needed.

A strong knife and a digger are requisite, for raising the bark of trees in searching for such insects as lurk there, and for exploring the burrows of those which inhabit subterranean retreats.

For collecting-bottles, common wide-mouthed phials, fitted with corks, will be found to answer; one should contain camphorated spirit, which does not injure some insects; and in another, bruised laurel-leaves may be put, when they can be obtained; or a collecting-bottle can be simply made thus: into the cork of the bottle tightly fix a small glass tube open at each end, containing a piece of sponge, the outer extremity of the tube to be fitted with a cork; a few drops of chloroform, allowed, from time to time, to fall on the sponge, will speedily kill any insects placed in the bottle. For *Moths* the chloroform-bottle is almost indispensable, and a more than ordinary wide-mouthed one should be selected for the purpose.

Add to these things, forceps, a pocket lens, a lantern with safety oil-cap and bull's-eye reflector for "*mothing,*" a setting-needle, which may be made by forcing the blunt end of a common needle into a piece of wood; a small and sharp-pointed pair of scissors for opening large insects, phials, chip boxes, braces made of slips of card-board, or, where they can be conveniently used, slips of glass, for extending the wings of moths; if the collector is for any time stationary, breeding-cages might be employed for rearing larvæ and watching the transformation of such insects as may be procured in their early stages. A cage may be made for this purpose two feet in length, the same in height, and from eight inches to a foot in breadth; the lower part, to the height of five or six inches, must be of wood, to contain earth for such larvæ as bury themselves previously to their metamorphosis, and the upper part covered with gauze stretched over a frame. It may be divided into several compartments, each provided with a door. The entomologist's equipment will now only want the setting-box. This, especially in tropical countries, should be covered, to exclude destructive foes, but at the same time so as to allow a current of air to pass through it and over the insects which are placed in it to dry. To accomplish this, a frame must be made eighteen inches long, fourteen inches high, and about the same in width, having a solid bottom and accurately fitting door opening in front; the whole should be covered with wire-gauze, and the interior fitted with three or four sliding, corked setting-boards, including the bottom, for spreading out insects. By this means the specimens within will be protected from those pests of the Naturalist, the cock-roaches and other destructive insects, which would otherwise, in an incredibly short time, destroy the results of a long period of labour.

9th.—A strong iron-clamped chest, with the lid grooved to receive a fillet, and made to contain a number of thin and shallow boxes with lids similarly constructed, should be provided for the smaller and more delicate bird skins, while for the larger skins, similar chests without the small ones would be sufficient. A collection thus protected, though not so numerous in species, would prove far more valuable than a more extensive one received in such a condition that little or no use could be made of it. Such disheartening instances are of too frequent occurrence. What was intended to be a noble collection, from being consigned to common packing-cases, has, after the lapse of a considerable interval, sometimes arrived from a distant country almost totally destroyed.

10th.—A good store of chip boxes, both round and oval, of various sizes, and nests of pill-boxes, should be provided for delicate shells, eggs, large *Coleoptera*, Crustaceans, Echinoderms, &c.

11th.—For procuring shells the collector should be furnished with one or two strong knives; a hammer and chisel for those which dwell in rocks; tin boxes and calico bags for specimens; a large iron ladle perforated at the bottom, or a strong hoop with a shallow bag of wire-gauze, made with a socket to fit on the end of a rod, for examining the bottoms of streams for small shells; a hoop net of coarse canvas for similar purposes; and a kind of dredge to fit, by means of a socket, on the end of a pole or jointed handle, might be added for such species as lie imbedded in mud.

12th—Large-mouthed, stoppered glass jars fitted in cases for specimens to be preserved in spirits, or wide-mouthed pickle-jars, which when well corked and coated with cement, will be found very useful for the same purpose; and a good supply of small stoppered bottles for Annelids, and other delicate objects, which should, as far as practicable, be preserved separately.

Lastly.—One or two additional pairs of scissors might, with advantage, be added, also the following articles, viz., needles, thread, silk, twine of different sizes, a few brushes both of camel's-hair and of bristle, card-board, coarse brown and thin white paper, calico, common muslin, bags of the two last named materials of different sizes for fish, &c. Chloroform for killing insects, a good supply of spirits, camphor, a quantity of alum, some pieces of cork, bungs; and finally a quantity of tow and cotton, to be regulated by the destination of the collector.

This equipment will of course require to be modified, reduced, or augmented according to circumstances and the locality fixed upon for exploration.

Before entering into the details of the methods to be pursued in the preservation of the different groups, it may not be amiss to allude to sketching, the utility of which is undoubted, when, as often happens, some rare or new object met with is, from a variety of causes, not preservable. A Zoological sketch to be of service to the Naturalist, must be something more than the mere contour of the specimen; it must contain the essential characteristics of the object; or, in other words, those points which Zoologists make use of in defining an order or a species. Thus, in *Mammals*, the form and number of the teeth, and of the claws, toes, or hoofs, should be represented; the form of the bill, position of the nostrils, length, size, and appearance of the feet and claws, form of the wings, &c., in *Birds;* and the parts of the mouth, form and size of the antennæ, and of the legs of *Insects.* These will serve as examples; for with different classes, different characters must of course be selected, and to those already mentioned others might be added; but with practise the eye will learn to fix upon, and a little consideration will suggest, the important points to be attended to.

MAMMALIA.

Here the rifle will be found especially serviceable, as by it alone most of the large quadrupeds can be procured; while the gun, loaded with large shot, will not be less so in procuring many of the smaller antelopes and deer; a charge of shot being found to produce a greater shock at the moment than a rifle ball, and the creature may thus be secured before it has time to recover, otherwise the almost invariable impulse, when an animal finds itself wounded, is, to seek the seclusion of some retired spot, probably in dense cover, and thus be totally lost. A small gun with lighter shot will of course be required for the smaller species. In all cases natives must, if possible, be secured as guides, to afford information and to assist in procuring specimens.

Every opportunity should be embraced of acquiring information relative to the several breeds of domestic cattle; indeed, the vast group of Ruminants, Wild Antelopes, Deer, &c., are all well worthy of attention, many of their habits being but imperfectly understood. The range of species should, if possible, be ascertained, and the extent and kind of influence exerted by local conditions in producing varieties traced. Care should likewise be taken to observe the changes produced by age in individual species, and to note the development of the horns of deer at different periods of life.

The *Rodentia* are another class well worthy of study, and any light thrown upon their habits and peculiarities will prove very serviceable.

The *Cetacea* likewise should be carefully observed, and no opportunity omitted of taking accurate notes and drawings, and of preserving parts, or the whole, of any individuals met with, excepting, of course, common and well known species.

The country to be visited will influence the collector's mode of procedure; and it is advisable to endeavour to obtain information, and to seek for suggestions from competent authorities as to what particular localities afford, and what should be especially observed.

Skinning.—First attend to wounds and staunch the flow of blood, if any, by introducing a plug of cotton, or otherwise absorb it. Suppose, for example, the animal to be a monkey, place it on its back with the head from you; cleanse the mouth and put in some cotton or tow, to prevent blood or any moisture from flowing out; separate the hairs down the middle of the belly to the right and the left, then make an incision from the sternum to the pubic arch, and if the skin be thin and delicate, let it be continued to near the arms; and here it will be necessary to state, that as the process of skinning proceeds, dry plaster of Paris should be laid on the exposed muscle, to absorb any blood, and to render the stripping easier by preventing the adhesion of the skin. Care must be taken not to cut through the abdominal muscles; and we would also add, to prevent unpleasant consequences, that if the operator is performing on one of the weasel tribe, or any other animal possessing mephitic glands about the posterior extremity, great caution is requisite to avoid puncturing these with the scalpel. When the incision has been made, let the skin be separated from the muscles of the belly on either side, far enough back to expose the outer part of the thigh, then bend the leg, push it forward, and separate it at the knee-joint, or, if preferred, at its articulation with the pelvis; this being accomplished on both sides, remove the skin from the anus, being careful not to cut through too close to the anal orifice, dissect the skin back a short distance from the base of the tail, fasten a piece of string round that organ close to the rump, attach it to some fixed object, and with the curling-tongs before-mentioned, grasp the exposed part of the tail, pull with a steady strain and the skin will be pushed off, with perfect ease, to its apex. To strip the skin from the back is a simple operation, and may frequently be done, as far as the shoulders, without the aid of the scalpel, which point being reached, expose the arms to the elbow-joint, where the separation may be made, or at the shoulder, according to inclination; continue the process by drawing the skin over the head, being especially particular to cut through the ears close to the skull; dissect carefully round the eyes, and avoid injuring the skin at the corners of the mouth; proceed with caution as far as the nose; it then only remains to separate the skull at its articulation with the neck, at the same time withdrawing the tongue. Clean the muscles from the skull, remove the eyes, and scoop out the brain through the occipital foramen, carefully preserving entire the base of the skull, as after the skin is mounted it may, perhaps, be removed for comparison. Now skin the legs down to the toes, though small animals will not require it further than the feet; remove the muscles, apply the preservative to the bones, the skull, and the skin in general; wrap tow, or some other material round the bones of the legs, to compensate for the muscle taken away, and replace them as before; pad the skull with tow where the muscle has been removed, fill the orbits with cotton, and return the skin over it; turn the skin, and if the animal is not too large fill it out with some soft material, but carefully avoid unnatural distension; sow up the opening, and the work will be nearly complete.

It will be requisite, before putting the specimen aside to dry, to anoint the bare parts of the skin with the solution of corrosive sublimate, and to repeat it twice or thrice Attach a little ticket, with a number to the specimen, and against a corresponding number in the note-book let all the particulars be placed; viz., the colour of the exposed portions of the skin, the locality where obtained, habits, whether or not the skins are articles of commerce, &c.

When animals are very large it will be necessary to cut the skin from the chin to the arms, and even to the end of the tail, and likewise down the inside of each leg. In the case of horned quadrupeds, such as deer, antelopes, &c., the incision along the belly must be continued to the chin, in order to skin the head and remove the muscle from the skull. Animals possessing peculiar tails, such as the beaver, will require to have a longitudinal cut made beneath to effect the skinning process. The ears of large quadrupeds, or of any animals which may have those organs much developed, should be skinned, and card-board substituted for the cartilage removed; this is a difficult operation, but it ought to be done if for no other reason than to retain their natural form and appearance.

It may frequently happen that means are wanting to preserve more than a part of an animal, particularly of large ones; in such cases the skulls, and if horned, the skulls and horns entire, accompanied with a full account of the entire dimensions, the probable age, colour of the hair, &c., will be found very useful. The horns of rhinoceri should accompany the skulls. The skulls of cetaceous animals should be secured, and if possible the entire skeleton. Directions for preparing skulls and bones for transport will be given under a separate heading.

It will be requisite to scrape the skins of some animals, as for instance, the seals, after their removal from the carcase, and before applying the preservative, in order to remove the fat.

For preserving the skins of large animals, a nearly saturated solution of alum, washed repeatedly over the inner surface will answer the purpose. A strong infusion of catechu is also very good. The skin should be spread out and hung up to dry, and when that has been properly effected, it may be rolled up and put away for transport; but if that is not done at the time, a careful examination should be made before it is finally packed up, to ascertain if it has been attacked by insects, in which case the injured parts must be washed with the solution of corrosive-sublimate, or with turpentine.

When, from want of means, an animal cannot be preserved, or, from its peculiar nature, its proper hue cannot be retained, which latter always happens with the *Cetacea*, an accurate drawing ought, if possible, to be made of it in its fresh state.

In skinning Bats it is not necessary, except in large species, to strip any part of the arms or legs. After skinning one of these animals, when the skin has been properly distended, the wings should be stretched out on a board with pins, and left to dry expanded; this is much better than allowing them to dry folded, as the specimens pack equally well, and the necessity is obviated of softening them before they are finally set up.

Birds.—The peculiar clothing of this class renders it of the highest importance that every precaution should be taken to prevent its being soiled, or its delicacy injured, both when procuring and when preserving the specimens.

A double-barrelled gun will prove extremely serviceable, and, if requisite, the barrels may be loaded with shot of different sizes; but although it has been frequently recommended to kill small birds with dust shot, we would suggest the employment of a larger size, inasmuch as specimens shot with the former are often found, on inspection, to be extensively mutilated, the shafts of the large feathers being frequently split and broken, and other injuries done to the toes and tarsi, from the quantity of shot which strike the object, while with the latter a bird will often be killed by a single lead drop, and the laceration of the skin is of far less consequence than injury to the feathers. The early morning is the best time to procure specimens, and next to that the evening; for at these periods the birds are in a greater state of activity, being busied in seeking their repast; it is then, also, that their songs are chiefly heard. During the heat of the day, again, in Summer and in hot climates, they usually repair to quiet retreats, and are little seen. Crepuscular and nocturnal birds must, of course, be sought for after sun-set, when their time of activity commences. In all cases specimens which have been snared are preferable to those which have been shot, and the assistance of natives will generally be found very serviceable in this particular, from their knowledge of the haunts of different species, and the peculiarities of their habits.

The collector should have a light box in which to deposit specimens procured; and if a number of paper cones, of different sizes, be made of cartridge-paper, before starting, and kept in the game box, it will save much time and trouble. When a bird has been shot, the flow of blood from the wound should be stopped by putting a little dry powder or a piece of cotton over it; and if a wing be broken, a piece of soft paper should be placed between it and the body, to prevent injury to the plumage; the bill should be opened, and a piece of cotton thrust into the mouth to absorb, and partly prevent the flow of, any moisture: the plumage should be put straight, and the wings closed on the sides, when the specimen may be put into one of the paper cones and deposited in the collecting box.

Skinning.—It will first be necessary to attend to wounds, and prevent the escape of blood from them, by sprinkling a little plaster of Paris, or covering the place with cotton; if an eye has been wounded, a piece of cotton should be applied, and a plug of cotton must also be put into the mouth; a thread should now be passed by the aid of a needle through the nostrils, and tied beneath the lower mandible, from which a loop is then to be formed proportionate to the size of the bird and the length of its neck, which is to be used in returning the skin to its proper position on the completion of the operation of skinning. If the bird be large, of delicate plumage, and much blood has flowed from the wound, which is frequently the case with water birds, as for example, the gulls, it will be necessary before commencing the skinning to sponge the soiled feathers first with lukewarm water, then with water having a little alum in it, and afterwards to dry them with plaster of Paris. Next, presuming the above directions have been attended to, place the bird on its back, with the head to the left, and if a small species, it is advisable to break the bones of the wings close to the shoulder; separate the feathers down the breast, turning them on either side; make an incision from the upper part of the sternum downwards to near the vent, but avoid cutting through the abdominal muscles; dissect away the skin from the body on either side, which can generally be effected by raising the skin with the fingers or with forceps, and separating it from the muscle with the handle of the scalpel, thus avoiding the possibility of cutting the skin. As the skinning goes on, a little plaster of Paris, or other powder, should be shaken over the exposed muscle, to prevent the feathers from adhering to it, by which means the process is facilitated, while the plumage is at the same time protected from impurities. When the thigh is exposed on one side, cut through the leg at the knee-joint, which, when the bird is not larger than a crow, can readily be done with scissors, then turn the bird round and proceed in like manner with the other side. When both legs are separated, continue to detach the skin backwards and downwards to the rump; raise, with the left hand, the bird by the tail, holding close to the rump, bend the tail back and with the scissors or knife cut through the coccyx or bones of the tail, leaving a part adherent to the skin to keep the tail feathers firm. As it frequently happens that at this point of the operation some fœcal matter will escape, it is better to prevent it by putting a piece of cotton into the rectum. The bird should now be suspended by the rump with a chain hook, and the stripping continued down to the wings, which may be separated from the body by cutting through the bone with scissors, except in large birds when they must be separated at the shoulder-joint; skin the neck and the head beyond the eyes, taking especial care on arriving at the ears not to pierce the skin, and in dissecting round the eyes not to injure the orbits; separate the head from the trunk at the first joint of the neck, at the same time draw out the tongue from the mouth and keep it in connexion with the trachea which should be removed entire and either dried or preserved in spirit. Scoop out the brain through the occipital foramen, and remove the eyes carefully, as the feathers of the head are frequently soiled by their bursting. The muscle should be removed from the base of the skull and from between the mandibles; preservative must then be applied to all parts of the skull, after which a little tow ought to be thrust into the cavity, and some cotton into the orbits; a thread somewhat longer than the body should now be fastened to the base of the skull, the use of which will be made known presently.

In large birds the wings should be skinned down to the elbow on the inside, and the bone separated at that joint, thence down to the wrist; an opening ought to be made on the under side of the wing, the muscle removed, preservative applied to the bones, cotton inserted, and the skin sewed up again; and further, a thread should be attached to each wing at the point where the bones have been separated, in order that they may be tied to the proper width across the back when the skin has been turned. The legs are now to be skinned nearly to the top of the tarsi, the muscle removed, preservative applied, and tow wound round the bones, when the legs may be drawn out naturally. Preservative must be applied to all parts of the skin, after which the process of returning the head through the neck is to be commenced by gently pushing the skull up, at the same time drawing the skin down with the fingers; and when it has been brought back to the base of the skull, turning the body partly over, and letting it lie flat on the table; then take the loop which is attached to the bill in one hand, place the other on the skin, and with a gentle strain draw the head out. Great caution and some skill are required to pass the large skulls of some birds, as the Owls, through the neck Dress the feathers of the head with a long needle, and the cotton which replaced the eyes should be loosened up, and drawn sufficiently far through the orbits to keep them of the natural size; open the bill and pass some cotton into the mouth, to keep the chin and upper part of the throat properly distended; and with a thread confine the mandibles for drying. Tie the wings at the proper width across the back; pass the thread which was previously fastened to the lower part of the skull, with a needle, through the base of the tail, and draw the neck down to its proper length; with some soft material fill out the skin to the proper size; close the opening by bringing the edges together with a few stitches; tie the feet together, and retain the wings in close contact with the body by a paper band. Apply some solution of corrosive-sublimate to the bill and feet, and when the skin is dry a specimen thus prepared is fit to be packed for transportation.

The foregoing instructions apply to the ordinary birds; but it will be necessary to allude to the methods to be pursued with peculiar species.

Long-necked birds with large heads, such as the Flamingo.—When half the neck has been skinned it should be cut across, and the remainder removed, and the skull exposed by an incision made in front of the neck from the throat, extending it sufficiently low down for the skinning to be effected without difficulty. It sometimes happens that the bird has a sort of crest, in which case a transverse cut may be made, if preferred, across the occiput, and the remaining portion of the neck taken away by first separating it from the skull. The incision down the neck is sometimes made on the side which is intended to be hid from view. The large skulls of some Parrots frequently oblige the operator to skin their necks by some such method; and some of the Ducks and Geese likewise require it.

Birds with large tarsi, as the Screamers.—It is not only of importance to attend to the feet of such specimens, in order to prevent the loss of the epidermis, but it is also requisite to retain the size and shape of the tarsi which in those birds, form a very prominent character. To preserve them, an opening must be made down the back of the tarsis, and the tendrons, &c., removed; some preservative is then applied and the space filled up with cotton. The edges of the skin need not be sewn together, but if simply brought in contact, and the tarsi bandaged with broad tape until they are dry, it will retain its proper place and unsightly stitches be avoided.

Birds with fleshy caruncles.—Such species are numerous, and the caruncles vary much in form, so that the operator must exercise his judgment in preparing and stuffing them, of course endeavouring to keep the opening as much out of sight as possible. It will also be requisite to take accurate notes of the colour of the naked skin, which in life is often very intense, strongly contrasted and beautiful, but which rapidly fades after death.

Birds with tumid nostrils, as Pigeons.—As in this Order the nostrils form a prominent feature, care must be taken to preserve them of the proper size and form. Make an incision from beneath into the soft and tumid portion, and after applying a little preservative, fill it out with cotton.

Birds with fat skins.—Most water-birds, Petrels especially, have a quantity of very oily fat beneath the skin, which, without the greatest care, will seriously soil the feathers; to avoid which, the oleaginous matter must be absorbed as the skinning process proceeds by using plaster of Paris, or placing cotton, rag, or bibulous paper, so as to protect the plumage. When the body has been removed it is still requisite to take away as much as possible of the fat from the skin by scraping it off, and absorbing the remainder with plaster of Paris; not only to preserve the feathers clean, but also to prevent the skin from becoming rotten.

Birds which are clothed on the breast with very delicate and satin-like feathers, such as the Grebes, are frequently skinned from the back, the incision being made from below the shoulders to the rump. The advantage derived from this is, that the purity of the plumage on the breast can be better preserved, and the appearance of a seam, which it is difficult to conceal, avoided; while the opening on the back is of less consequence, as there the seam can be better disguised by the difference in colour and arrangement of the feathers.

Some time should elapse after a specimen has been killed before attempting to skin it; but if from any cause it is found necessary to skin a bird immediately after death, which, from the rapidity of putrefaction, as well as from other causes, will sometimes happen in very hot climates, care must be taken to injure as few as possible of the large vessels, and some cotton should be at hand to staunch the flow of blood. The blood will be found to flow freely from most water birds even at a considerable time after death, so that the same precautions are necessary.

When the skins are dry they should be examined, and, if found free from the attacks of insects, packed with camphor in the boxes intended to receive them.

Long-necked birds are sometimes stowed with the neck folded down beneath one wing, which practice has been recommended by some; but, if possible, it should be avoided, as some of the feathers dry in an unnatural position, which it is impossible afterwards properly to rectify.

Notes should be made of the colour of the irides of the specimens procured, and of the bill and feet.

The alimentary canal should be kept either dried and inflated or preserved in spirits, or an accurate sketch should be made.

The *sterna* of the different birds skinned should likewise be kept; the mode of preparing which will be given with the directions for bones and skeletons for transportation.

REPTILES AND AMPHIBIANS.

The assistance of the inhabitants of the places visited will, perhaps, be found of fully as much service in this as in any branch of Zoology, not only in obtaining specimens, but in furnishing native names, and making known the haunts of different species, many of which, especially some of the Amphibians, lurk in obscure places, and thus might be overlooked by the collector; nor is this all, for information may be procured relating to those species which should be avoided in combat, and which should be captured with care.

A very slight blow across the spine of a snake will sufficiently paralize it to stop its progress; when secured, with a small and sharp-pointed penknife, or some such instrument, wound the spinal-cord immediately between the base of the skull and the first vertebræ, which, without injuring the specimen, will instantly put an end to its power to escape or to do harm ; this can readily be managed, supposing the species to be a venomous one, by placing a stick on its head while the operation of pithing is performed. A little noose of fine copper wire fastened to the end of a rod may sometimes be serviceable for capturing specimens.

All small species are best preserved in spirits, and it is only the larger ones which should be skinned. When a specimen is put into spirit, care should be taken to allow some of the fluid to get into the intestinal canal which can most certainly be effected by injecting it into the mouth with a syringe; the neglect of this precaution often causes the loss of the epidermis about the lower part of the abdomen, even when specimens are placed singly in strong spirit. When collecting for transportation, too many specimens should not be put together into one jar, as the quality of the spirit frequently becomes so deteriorated as to destroy its preservative properties.

Skinning.—Turtles may be prepared by separating the *plastron* from the *carapace*, which can be very readily done by cutting it through at the sides with a strong knife; but for tortoises it will be necessary to use a saw, in order to separate one side, when the plastron may be elevated and forced from its connexion with the other side, where the bones unite, but before it is raised, let the skin around the legs, tail, and neck, be separated from it. When the specimen is opened all muscle and fat can be easily removed, and the neck, feet, &c., skinned as in other quadrupeds; which being accomplished, and the preservative applied, these parts should be filled with cotton, to keep them distended to the natural size. The plastron may be confined to the carapace by a piece of twine tied round them, which will answer the purpose until the specimen is finally prepared.

Lizards may be opened and skinned like other quadrupeds, but especial caution must be observed in skinning the tail, which operation is rendered extremely difficult by the brittleness of that member; and in such species as possess very long and slender tails it is better not to attempt it. When filling out the skin of such species as possess a gular pouch, attention should be paid to that part, so as to keep its proper size and form; and when a specimen possesses a dorsal or other crest, it will be well to keep it properly stretched with pins, upon cork, until it is dry, in order to avoid the necessity of relaxing it when the skin is set up.

In filling out the skins of such species as have very depressed bodies, the operator should carefully preserve the natural form.

Snakes.—In skinning snakes, an incision of three or four inches in length should be made on one side of the neck, commencing from behind the jaw; the skin must be laid back and the head separated from the first cervical vertebra; if a piece of twine be then made fast to the neck and tied to some fixed object, the skinning may be speedily accomplished, by drawing it back and dissecting with the scalpel a little beyond the vent, when it will be sometimes necessary to make another incision along the side of the tail, towards the tip, in order to skin it. *The entire skeleton may be very easily preserved along with the skin, by dissecting the skull out instead of detaching it from the vertebræ.* When the skin has been removed and preservative applied, it may be allowed to dry without being distended, and when perfectly dry it can be rolled up and packed away in small compass.

Amphibians.—Whenever it may be desirable to skin any large toads or frogs, the process can be effected as with other quadrupeds; the skin, after the application of the preservative, should be filled with sand, or some such material, as it enables the operator to mould the form into the natural shape much better than if any other stuffing was used.

FISHES.

Whenever practicable, fish should be preserved in spirits, a quantity of which should be forced into the abdominal cavity of each specimen, before it is placed in the collecting-jar; it is advisable also to enclose each individual in a calico or muslin bag, to prevent injury from rubbing against other objects. Delicate species ought not to be placed indiscriminately with tougher kinds, but should be kept in small numbers by themselves, and be preserved in camphorated spirit. Each, when placed in the collecting-jar, should have a tally attached to it corresponding with a number in the note-book, where all necessary particulars should be recorded.

Skinning.—Extreme caution is sometimes necessary in skinning fish to prevent the loss of scales; those species, therefore, which have this covering loosely attached, should have a piece of tissue or other thin paper pasted over them, or be covered over with mucilage before the operation is commenced.

Fish, such as the *Perch*, may be preserved either entire or as sections. For the former method, an opening is made along the abdomen extending the entire length of the fish, or along the lateral line; in either case, the skin is to be turned back on both sides, the head separated from the vertebræ, the fins cut through with scissors, and, when the whole body has been skinned, the fleshy portion and spine are to be divided at the tail; the different parts of the head, where there is muscle, should then be attended to; and although it is always difficult, and frequently impossible, to remove this, yet an opening in it may be made with a blunt scalpel, to enable some preservative to be applied, and more particularly in order that stuffing may be thrust in, to compensate for the contraction of the muscle in drying. After the application of the preservative, the skin should be filled out, the form of the fish being carefully preserved on one side, after which the opening may be sewn up. It is recommended that, when circumstances permit, the fins should be stretched with pins on cork, as they can seldom be so well expanded after having once been dried.

To prepare sections of fish, the skin must be cut all round along the base of the fins on one side, separating it from the head, which, however, must be left entire; that part of the skin is next to be taken away, and the body may then be removed in the usual manner. The proper form and convexity are to be given to the section by pinning it upon a thin piece of soft wood and stuffing it, at the same time expanding the fins. When the skin is dry, it may be removed from the board and packed. In preparing the skins of fish the gills should, as a general rule, be allowed to remain; but when, from their size, they are likely to retain too much moisture, they ought to be carefully removed, and dried separately. The palatal bones and other parts of the mouth should never be mutilated.

Sharks.—The whole of the body and head must be removed in skinning these animals, leaving the jaws attached; and as the skin is closely and firmly connected to the muscle it will be necessary to dissect with much caution; if the skin be filled out, the natural form, especially of the head, should be accurately retained.

Rays.—These should be opened on the ventral surface by a semilunar incision; in small specimens little more can or need be done than to remove the viscera, and detach the skin, by the handle of the scalpel, from the more muscular parts, to enable the operator to apply preservative and insert stuffing. More will be required in large specimens, but the skinning cannot be carried to the edge of the fins.

Flat-fish should be preserved entire, the opening being made on the ventral edge and carried along the fin on the colourless side.

Eels may be skinned in the same manner as snakes, an opening being made in the skin for a short distance along the neck, when the head may be separated and the body removed. The skin may be filled with sand to distend it, which will facilitate the operation of moulding to the proper form, and, when dry, the sand may be allowed to fall out.

Trunk-fishes.—These being enveloped in a hard and solid covering, a different process is necessary. A portion of the external coat, of an oval form, must be cut out from the belly, by which means the viscera, &c., can be removed; the vertebræ and muscle from the tail may generally also be taken away by the same opening, but if not, an incision should be made along the skin of the tail to effect it, in order that stuffing may be introduced, and thus prevent the shrinking of that part. It will not be necessary to do more than apply preservative to the inside of these fish, as they will retain their proper form when dry.

Fish-skins should be packed in comparatively shallow boxes, to avoid too great pressure on the lower specimens, and each one should be covered with thin paper, and have the fins properly protected with cotton. Tow, or some soft material, should be placed between the layers of skins, and camphor should be placed in the box.

Directions for Collecting Bones and Skeletons.

The preservation of bones and skeletons has been generally much neglected by collectors, and while the skins of peculiarly interesting animals are often very common, their skeletons are extremely rare, or altogether unknown; and yet skulls, bones, and entire skeletons of animals can be, in most cases, prepared for transportation as readily as skins.

Skulls may be prepared by removing the principal part of the muscle, and allowing the remainder to dry; or, where convenient, they may be boiled first, which will greatly facilitate the cleaning process, and, when thoroughly dry, they may be separately wrapped in paper and packed; small skulls, in cold climates, may be dried with the whole of the muscle attached; but in all cases the brain should be removed.

Separate bones may be prepared in the same way, and the long bones of large animals should be bored at each end to permit the escape of the medullary matter, but the holes should not be very large.

Skeletons.—To prepare the skeletons of large mammals, the muscle should be removed, and the bones boiled, or they may be dried at once, but the former method is preferable, though, perhaps, not often practicable; in either case the bones should be separated, as, by so doing, they will not only dry more quickly, but can also be packed in smaller compass. In separating the bones, the cartilages of the ribs which are attached to the sternum should be separated with it, the disunion being made at the end of each rib. When a skeleton is boiled, the sternum and cartilages of the ribs should not be included; the cartilages of the scapulæ should likewise be kept above the water.

The paddles of the Cetaceans should not be boiled, but the skin and fat be removed with the knife, and the bones, with their natural attachments and whatever else may adhere to them, be allowed to remain until the final preparation.

The skeletons of smaller animals may, in cold climates, be very easily preserved by removing a few of the larger muscles and allowing the remainder to dry. In warm or temperate climates it will be necessary to dissect away more of the muscle before drying them. The viscera must always be removed.

The skeletons of Birds may be prepared in a similar way, and it will serve as an additional protection from injury if the primary wing feathers are allowed to remain attached, so that when the head is bent down along the side of the body, and the legs folded up, the wings may be closed and confined with a piece of twine, while the quill feathers serve to enclose the whole within a small and safe package. It will be requisite to remove only the viscera and pectoral muscles of small species before drying them.

The *sterna* of such birds as have been skinned may be preserved by removing the large pectoral muscles, and drying them. The furcula, clavicles, and scapulæ, should be allowed to remain attached to each sternum; all the rest can be separated.

Reptiles and Amphibians may be prepared as the Mammalia, the large species having the bones separated, and either boiled or dried at once, and the small species having the chief part of the muscle removed and dried entire; with some it will be sufficient to remove the viscera only, and then dry them. *Turtles* and *tortoises* may be preserved by removing the plastron from the carapace as directed for skinning, dissecting the muscle from the neck and extremities, and taking away the viscera and fat from the interior of the shell. Most of the small species of Reptiles, and particularly the Amphibians, which are intended for skeletons, will be best preserved in spirits.

Fish.—The heads of fish may generally be preserved by removing some of the muscle from the cheeks and drying them, or where rapid dessication can be effected, they may be dried entire. The whole fish may frequently be preserved for a skeleton by removing the viscera and drying it; or when it is too large, or, where, from other causes it cannot be dried with sufficient speed, the muscle may be removed from the back and the sides of the tail *en masse*, commencing by making an incission along each side of the dorsal fin, from the back part of the skull to the caudal fin, and continuing it round to the anterior part of the anal fin, when the greater portion of the muscle can be dissected away on either side separately, taking particular care not to interfere with the ribs, or the styles which branch off from them, and which are sometimes continued along the vertebræ nearly to the end of the tail. In some fishes, such as the eels, it will not be so easy to remove the muscle, on account of the number of small bones which pierce it. Such specimens as are intended for skeletons and cannot be otherwise prepared, will be better preserved in spirits provided it is of good quality, that too many specimens are not placed together in it, and especially that it may have free communication with the abdominal cavity, otherwise the ribs will lose their attachments to the vertebræ. Skeletons and bones preserved according to the foregoing instructions and carefully stowed in boxes with soft packing, can be as well prepared afterwards as fresh specimens, provided they are not allowed to get wet after being packed.

MOLLUSKS.

In collecting *Mollusca* the dredge is the important instrument, a single scrape of which, in deep water in an unknown portion of the bed of the sea, is worth hours searching along the strand. "Having arrived at the fishing-ground, ascertain the depth of the water and the nature of the bottom with a sounding lead; register these data, which are of the greatest importance, in a pocket journal; drop the dredge overboard, allowing one-third more line than the ascertained depth, and drag the dredge along by sailing or rowing; when full, let it be dragged into the boat. Let the Nudibranchiate-Mollusks, Holothurians, and other soft animals, demand your first attention; make a sketch of all rare and curious forms, and wrap each specimen in a piece of tin-foil before putting it into a bottle of alcohol, or, if you desire to study their habits to advantage, place it in a bottle of sea-water. The remainder of the contents is thrown into a tub, and the dredge lowered whilst it is being sorted." When the contents of the dredge are muddy, they must be placed in wire sieves and water poured on them till the shells remain visible at the bottom. The best grounds for dredging are those of sand, smooth stones, sandy mud, and sea-weed bottoms; rocky and coral bottoms often tear the bag and break the line of the dredge. The greater the depth dredged, the more important the results; and the objects secured, though few in number, will frequently be either new or very rare.

The best description of dredge is that invented by Mr. Ball, of Dublin, the cost of which is only about seven shillings, its weight seven or eight pounds, and which may be stowed in a carpet bag of moderate size. In this dredge "the two scrapers are each twenty inches in length by two inches in breadth; parallel with their lower edges, fourteen holes are pierced equidistant from each other, to receive the laces of the bag. These two plates, or scrapers, are joined by means of two cross-bars, so as to form an angle of about forty-five degrees with the plane of this position; each bar is five inches in length by three-and-a-half-eighths in diameter. The arms are each sixteen inches in length by three eighths-and-a-half in diameter, and play upon the cross-bars by means of double swivel-joints. Their anterior extremities are beaten flat, so as to meet closely and vertically, and are pierced, for the reception of the bolt, which at the same time passes through the extremities of what may be termed the bridle-ring, to which the rope is affixed." By drawing the bolt and folding the arms inwards the dredge is readily stowed away. "In no case should the bag exceed eighteen inches in depth; one may be best made of twine, with meshes half-an-inch apart, and another of cheese-cloth or serge for fine work." The net may also be formed of a raw hide, with holes punched in it. The strength of the rope must be regulated by the depth at which the dredge is used, but in all cases a fourteen pound weight should be attached to the rope at the distance of six inches from the dredge.

Small hand-nets made of cheese-cloth and fixed to an iron ring with a socket, for a walking stick, will be useful, or a circular tin spoon pierced with holes, will answer the same purpose, namely, for scraping the bottoms of pools for small delicate shells.

Several moderate-sized sieves are also requisite for sifting mud and sand, and for washing the contents of the dredge. These may be four or five inches high, and the meshes of their brass or copper bottoms should be one-tenth of an inch apart. These sieves should be filled, and the contents frequently washed by pouring water on them, or by repeated dipping in the sea, by attaching three strings to the sides, which are held in the hand. When the ship is at anchor "fishing" for Mollusks may be carried on by dropping a fine line with a small hook baited with a bit of flesh. In this manner Olives, Marginellas, Harps, and Volutes may be taken. The same method may be adopted among rocks, and coral-banks, where the dredge cannot be used. The ship's anchor will sometimes bring up shells sticking to the mud on the palms. Where divers are employed valuable species may often be obtained from the stones, sponges, madrepores, &c., they may bring up, and in the middle of which they are concealed. The stomachs of fishes of all descriptions should be carefully examined, many among them, especially the ground-feeders, being excellent Conchologists. Acquaintance should be made with the fishermen of the place, who often procure rare shells in fine condition; these men are often acquainted with the localities and habits of *Mollusca*, and must be questioned.

The markets must be frequented and searched, many interesting species of Mollusks being used in different countries for food, lamps, and other economical purposes. The Malays and Chinese collect great heaps of shells for the purpose of burning them into lime for mixing with their betel-nut and sirih-leaf for chewing. Fluviatile shells must be obtained by the spoon and the water-net, except in lakes, where the dredge may be employed. Many species are found adhering to the under surface of dead-floating leaves, or clinging to old trees and logs in the water, or crawling on the stones partially out of the water, or along the oozy banks; while many again will be discovered partially or entirely buried in the mud. Land shells are taken in the greatest abundance after showers and early in the morning, or during the evening and night; they are found crawling on the leaves of plants or on the the ground among damp moss and dead vegetable matter, under heaps of stones or loose bark of trees, or in holes of their trunks and fissures of the bark, or along pathways, and in fields, woods, and heaths. Many of the smaller kinds may be taken by sweeping the bushes with a net.

The littoral species of *Mollusca* are found on the reefs and rocks which the sea leaves uncovered on the receding of the water, and where they hide under the stones until the tide returns. They are often most numerous after a storm; stones must be turned, the heaps of sea-weed raised and their roots examined, the little pools must be explored, fissures of rocks peeped into, and coral-masses broken and uprooted. Starfishes, and other Echinoderms and Sponges must be very carefully examined for parasitic species which bury themselves in the skin, and which may be detected by the tumours they produce, or by the holes they inhabit.

The rocks must be keenly searched for Limpets and Chitons, which frequently assume the colour of their habitat, and require a practised eye to detect them; they must be taken by surprise, and suddenly lifted off by the point of a knife before they can fix themselves firmly. The internal parts of the Limpets can be simply removed, but the Chitons must be placed in fresh water, their inside carefully removed, and then strapped down upon thin strips of wood; tied to layers of talc and placed in spirits is the very best mode, taking care, however, not to injure the gills or margins of the mantle.* When the sea bathes the roots of trees, as the Mangroves, which it does in many parts of tropical shores, *Littorinæ*, *Ostreæ*, *Neritinæ*, and *Auriculæ*, will be found on their trunks, and among the branches and roots that are out of the water. Bubbles of air will shew where shells are hid in the mud or sand, as will little hillocks, grooves, holes, and vermicular-formed heaps of excrement. The burrowers in the sand must be turned out promptly by a digging implement of some sort, taking care not to crush the valves by the pressure of the soil around them. The *Pholades*, and other bivalves that live in calcareous rocks, may be detected by the holes and tubes they form; the shells must be carefully broken out, and, when a tube is attached, it must also be preserved with a portion of the rock.

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* Chitons placed in salt-water on a piece of slate will adhere naturally, and may then be removed, and their backs held to the fire, when they will dry nicely *in situ*.

Most *Mollusca* are killed by plunging them into hot water; when, however, they are very delicate, the water should be added gradually. The animal, when dead, is removed with a pin or piece of crooked wire, or, if a bivalve, with the point of a knife. The operculum, when present, must be carefully wrapped up in paper and placed in the mouth of the shell; the bivalves must be tied together with string or thread. The marine shells may be soaked in water before being put away, to extract the salt, but no cleaning process, or oiling of the specimens, should ever be attempted.

Shells are best packed in shallow boxes of moderate size, so as to contain but a single layer, these shallow boxes may then be packed in bulk with saw-dust or shavings between them. In packing the boxes, cotton must be placed between the specimens, and very fragile individuals must be placed separately in pill-boxes, and the pill-boxes stowed in the shallow boxes. When the animal is removed from a large shell, it is sufficiently valuable for preservation. If for anatomical purposes, it should be placed in spirits, to which a little ammonia has been added, to keep it soft; if for zoological observation, simple alcohol will answer the purpose.

INSECTS.

No spot should be overlooked by the collector in searching for Insects, as the places in which they lurk are as numerous and diversified as the forms of these creatures themselves. The thick wood and the sandy plain, the hedge-row, and the mouldering bank, the flowers which bedeck the fields and perfume the atmosphere, as well as the putrid carcase which fills the air with repulsive odours, must each be carefully explored; the bark of trees must be raised, and decaying timber broken up, in search of the species which inhabit such localities; and old banks and sand-pits must be closely examined for the *Hymenoptera*, which burrow in them. The Entomologist must sometimes patiently turn the stones on the shore; at others, he must dabble in the dark still pool; at all times and in all places he must be on the alert, for he may extract a Carrion-beetle from a filthy mass, or capture a Bee as it sips the nectar from the flowers; he may net a Butterfly in the brilliant sunshine, or secure a Moth as it flits about his midnight lamp.

When it can be made convenient, the collector will find it advantageous to prolong his visit in any place he may select for exploring, as by such means a better knowledge can be obtained of what the locality affords, and much information may be gleaned relative to the habits of species; if he reside for any length of time in a particular spot, he should not fail to employ a breeding-cage, not merely because many rare species are seldom to be procured except in this way, but also on account of the light which the breeding of insects throws on their metamorphoses; all the observations made should be carefully recorded, and it will likewise prove of great service if drawings are taken of larvæ and pupæ, and of the plants on which the former feed.

Preservation of Insects for transportation.—In preserving *Coleoptera* for transport many may be kept in camphorated spirit; but such as are hairy had better be pinned down and dried, the pin being always thrust through the right elytron, and if time permit, the legs and antennæ should be placed in their natural positions at once; but, if inconvenient, that can be left for a future time, when the specimens are reset for the cabinet. Large species of *Coleoptera* may be killed by immersion in hot water or spirit, or by chloroform, the legs and antennæ can then be folded up, and the specimens dried and placed in separate card- or chip-boxes, with cotton to protect them from injury. All species large enough to be fastened with pins, can be so done and dried, but more time and space are requisite, and the specimens are more likely to receive injury; very small species must be put on little slips of card with gum-tragacanth.

Euplexoptera and *Orthoptera* may be preserved in spirits, but they are better set out at once and dried. The pin should be put through the thorax, the wings kept closed, and large species must be opened along the under side of the abdomen, the viscera must be removed, and the cavity filled with cotton.

Neuroptera and *Stegoptera* should be set up at once and dried, the wings being kept in that position which is natural to the species when at rest; the pin being inserted through the thorax. They are most easily killed by chloroform. Some may be better preserved in small glass tubes.

Hymenoptera are preferably to be pinned through the thorax, and set at once with the wings expanded; small species must be put on card. Chloroform is the best mode of killing these insects, and when dead they should be removed from the collecting-bottle, and put into a dry box, otherwise the soft hairy covering of some species becomes much disfigured by moisture.

Lepidoptera.—The delicacy and beauty of this Order demand that the utmost care should be taken in preserving the specimens, as the slightest touch is sufficient to remove some of the scales which cover the wings, and at every such loss some colours disappear; it is, therefore, necessary that some speedy method of killing them should be adopted, and the best and most effectual agent for Moths is chloroform, as it immediately stupifies them, prevents their fluttering, and quickly terminates their existence; Butterflies can be instantaneously killed by compressing the thorax. Specimens should be put out at once by being transfixed through the thorax, the wings being expanded and kept in that position until dry, by means of braces of card or slips of glass; the latter are best when they can be conveniently used, as their weight is sufficient to retain the wings in any position; and the smoothness of the surface and transparency of the material, afford advantages which are not possessed by any other, so that the operator is enabled to see whether the wings are properly placed, and he can alter and adjust them without removing the slips. Moths are best set by pinning them to cork, grooved so as to receive their bodies. Large-bodied species must be opened and filled with cotton, as described for the *Orthoptera.*

Hemiptera should generally be set out at once and dried, the pin being thrust through the thorax, and the wings closed. Some may be preserved in spirits, others placed on card.

Homoptera.—Some of these may be preserved in spirits, but they are better when put out at once, a pin being run through the thorax, and the wings kept closed. Some are better kept in small glass tubes.

Strepsiptera may be put on card or preserved in small tubes.

Diptera should be preserved dry, the pin piercing the thorax, and the wings being expanded. Small species must be put upon card.

Aphaniptera should be preserved in small glass tubes, or they may be put upon card.

Caterpillars are best preserved in spirits; but as the colours of the smooth-bodied ones are very evanescent, they should be noted at the time, or, as previously mentioned, drawings should be made.

Whenever mould makes its appearance on insects preserved in boxes, they should be touched with camphorated spirit applied with a camel's-hair pencil; the same thing should be done when mites are observed, or they may be touched with a weak solution of corrosive sublimate in alcohol. Camphor should always be kept in the boxes.

Aiolopoda.—The greater number of these will be best preserved in spirits, though some, such as the Sugar-lice, should be kept in small glass tubes.

Arachnida.—These are all best preserved in spirits.

Crustacea and *Epizoa.*—Some are best kept in spirits, but many may be preserved in a dry state, to effect which, the specimens must first be placed in fresh-water for two or three hours, to remove the salt, when they may be opened by removing the carapace in Brachyurous, and by separating the tail from the thorax in Macrourous Crustaceans, and taking out the soft parts, at the same time, the muscle from the large chelæ of Crabs and Lobsters should be drawn out by means of a crooked wire, and if the specimens are very large, it should also be taken from the other legs; a little preservative may then be applied, the separated parts reunited, and the specimens set aside to dry, after placing the legs and antennæ in their proper positions.

Cirrhopoda.—Many of these are best kept in spirits, indeed some specimens of all species should be so preserved. To preserve them in a dry state, they must first be put into fresh water, as mentioned for the Crustaceans, the pedunculated species should then have the peduncle stuffed with cotton, to keep it of the natural size and form when dry, the valves should also be kept apart by the same material, and the arms of the animal allowed to dry protruded. Sessile species should be emptied of the soft parts of the animal, the shell filled with cotton, the opercular portions placed in their natural position on the cotton and fastened to it with gum, and when the specimens are in groups, the arms of some of the animals should appear through the openings.

Specimens of Crustaceans and Cirrhopods ought to be packed very carefully in soft materials, particularly the former, and, as far as practicable, they should be placed separately in chip-boxes, and have camphor put with them. In case of their becoming mouldy or infected with mites, they may be treated after the manner described for insects.

Annelida.—All the species are best preserved in spirits, and for those which are not liable to be corrugated by it, undiluted spirit is preferable. The specimens should, as far as possible, be kept separate in small bottles.

RADIATA AND ACRITA.

Star-fishes, Sea-urchins, Sea-cucumbers, and other Echinoderms are best preserved in camphorated spirits. If any specimens are required for subsequent dissection, they should be preserved in alcohol, to which a little ammonia has been added.

The Brittle-stars, however, must be suddenly plunged into fresh-water to prevent them from throwing off their arms, and then transferred to the spirit; to preserve them dry, they should be dipped for a moment in boiling-water, dried in a current of air and packed in paper. The Sea-urchins or *Echinidæ*, after the inside has been carefully removed, preserving, however, the skeleton of the "lanthorn" or jaws, should be sewed up separately in muslin bags, to preserve their spines, previously having submitted them, for several hours, to a bath of fresh-water.

When parasites are found, such as Cavitary or Parenchymatous Entozoa, the part to which the animal is attached should be removed along with it, in order to preserve the mouth, hooks, or sucking disk by which it adheres. These kinds of animals will be found in the intestines, liver, &c., of many animals which are opened, and also adhering to the gills and noses of fish. They should all be carefully collected and placed in alcohol diluted with about a third of fresh-water. Coloured drawings should be made of Sea-nettles or *Acalephæ*, as the beauty of their forms is never preserved after death, even in spirits; they must be placed in tumblers of sea-water, and drawn while in their living state. After placing them in the spirit it must frequently be changed after the specimens have remained in it for some time, as a very large amount of fluid exudes from their gelatinous bodies, and weakens its preservative power.

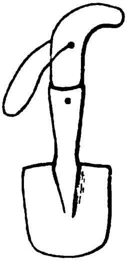
Fleshy-polyps, Sea-anemones, and similar forms of invertebrate animals, must be preserved in diluted spirits. By gradually adding the alcohol to the sea-water containing the living specimens, the animals may die in an expanded state, when they should be transferred to some fresh spirit. The same thing may occur if a minute portion of corrosive sublimate is added to the water.

To capture Infusorial-animalcules or minute phosphorescent forms, and other microscopic creatures floating near the surface of the sea in calms, sheets of stout bibulous paper should be lowered, raised in a horizontal manner, and afterwards dried and preserved in a book with the little invisible animals adherent to the papers.

Sponges and horny and calcareous Corals, should be steeped for a considerable time in fresh-water, to extract the salt, and then dried in a current of air.

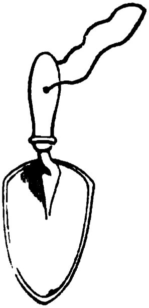
II.—PHYTOLOGY.

As the collection and preservation of plants, and of vegetable products, are subjects of much importance to the travelling phytologist, it may be advantageous to insert for his use some brief directions when to gather, what to choose, and how to prepare, as the value, both scientific and intrinsic, of an herbarium depends far less on multiplicity of objects, than on the careful selection, and the state of perfection of its contents. The instruments and apparatus required by the itinerant botanist are by no means so bulky as those of the zoologist, nor is the preparations of his specimens so complex or so tedious. His equipment should comprise,—



1.—*A digger*, which is a kind of minature spade; that usually employed, is from seven to eight inches in length, the spud being two inches and-a-half long, the same in width at the upper part, but slightly narrowed across the bottom, and with the lower angles rounded.

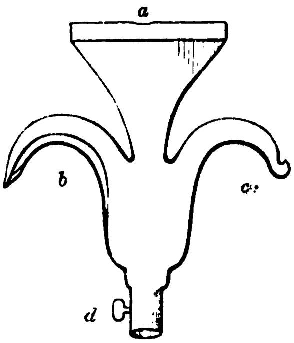
Another form which we would more particularly recommend, is the one here represented, which is more trowel-shaped, the spud being five inches long, and concave in front. These should be constructed of sufficient strength for digging out plants in hard or stony ground. It will be found convenient when using these instruments to have them attached to the wrist by means of a loop of cord passed through the handles.



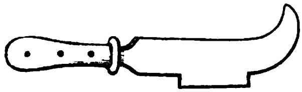
2. *A Botanical-box* or *Vasculum*; this which is indispensable for long excursions, and particularly in hot climates, is made of tin and usually japanned. Two or three different sizes are required, the largest being twenty or twenty-one inches in

length, from nineteen to twenty inches in circumference, and five inches in depth, of an oblong depressed form, convex externally, the curves of the opposite sides being similar. It should have a strong handle at one end, and open on the upper surface by a lid thirteen inches long, fastened, when shut, by means of two hooked wires sliding into tin sheaths. It is generally advantageous to have a small compartment at one end, about an inch and-a-half in depth, in which labels may be kept ready for attaching to plants, or small specimens may be preserved separately. This case should have a couple of tin bands placed along one of the sides, to permit a leather strap to be passed through, for the purpose of of slinging it across the back. The next size which is useful for ordinary walks, or for short excursions, and is adapted for being carried in the hand, is four-fourteen inches long, five inches wide, and two and-a-half inches deep, and has only a handle at one end. The third should be small enough to go into the pocket, and the upper surface may be concave.

3.—*A Field-book*, which is merely a portable portfolio containing absorbent paper, and secured by a couple of straps. Flaps of oiled-silk or other thin water-proof material, should be attached to either end, and along the inner edge of one side, for the purpose of protecting the contents from wet. This is employed for preserving small and very delicate plants, or flowers which are deciduous or fade quickly, which may thus be spread out and pressed immediately on being gathered.



4.—*An instrument*, which will be better understood by the accompanying outline than by description. The upper edge *a*, is sharp, and fitted for cutting specimens from the trunks or large branches of trees; the curved edge *b*, is for cutting branches out of ordinary grasp; and *c*, is a blunt curve for hooking them down for the sake of any particular part. It may be fitted to a long handle by a ferule, and secured by a thumb-screw *d*.



5.—*A portable Bill-hook*, with a hatchet edge along the back; this may be carried in a curved scabbard, which can be attached by a button or similar contrivance to a belt, or otherwise slung at the side. The handle should be made of two pieces of rough leather secured to a central plate by rivets.

6. Two or three good strong *jack-knives*, and a smaller *sharp-pointed knife*.

7. *A pocket-lens;* one with two glasses is preferable, and it is safer to carry it in a breast pocket, attached by a piece of ribbon or small cord to a

button inside the pocket, so that when not in use the whole is quite out of the way.

8. *Paper.* The kind chiefly required is "drying-paper," which is now manufactured expressly for botanical purposes; in Scotland, by Weir, Queen street, Glasgow ; and in England, by Bentall, whose London agent is Mr. Newman, No. 9, Devonshire-street, Bishopsgate. The most convenient size for general use is 18 inches long by 11 inches broad, which sells at 18*s.* a-ream. This should be kept in fasciculi of three sheets passed within each other, except for very succulent plants, when four will be necessary ; also a small quantity of thin white paper, usually known as "Crown tea-paper," which is used for holding some delicate plants, before being placed in the "drying-paper." In damp countries nothing answers better than coarse *brown* paper. For some *Algæ* a very bibulous paper, such as ordinary blotting-paper, is preferable. A quantity of common writing-paper for cutting into small slips, for attaching to specimens, should likewise be provided.

9. Pieces of thin unglazed *Calico* are frequently placed next to such plants as are apt to adhere to the drying-paper.

10. *A Press.*—For travelling purposes the most convenient method of pressing plants, is by placing the bundles of drying-paper containing them, between two stout boards, which should be larger than the paper by a quarter of an inch each way, of an inch and-a-half in thickness, and each having two bars or batons of two inches in breadth, and five-eighths of an inch in depth, and rabbited, let into

them across the grain, to prevent their warping. To equalize the pressure the heap must be divided by thinner boards, of from a quarter to three-eighths of an inch in thickness, inserted at intervals. On the top of the whole a weight should be placed, varying from 90lbs. to 180lbs. When stationary for a time, the most simple mode of applying pressure is by means of stout duck or canvass bags containing sand, or fine gravel, which can be filled and emptied at pleasure; but while moving, the best means of securing the parcel, and at the same pressing the plants, is by a rope run twice round the boards and tightened by a rack-pin.

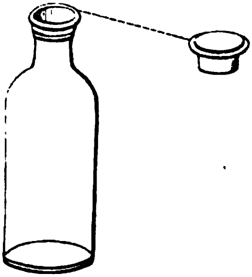
11. A pair of *botanical-forceps*, or, where these cannot be procured, a pair of *surgeon's forceps* with rather fine points.

12. A *setting-needle*, employed in spreading out delicate plants, and especially *Algæ*, easily made by inserting a stout needle into a wooden handle: a porcupine's bristle answers this purpose well.

13. A *small saw* will frequently be serviceable for cutting off portions of branches or sections of small trunks for specimens.

14. A *small drag* for searching the bottoms of pools for fresh-water species; this can be made by fastening four or five stout fish-hooks together, after the fashion of a boat's grapnel.

15. *Bottles* and *jars* for preserving moist specimens. The bottles we would recommend as well adapted for such purposes are similar to those now made for containing pickles, &c., with a rim around



the outer edge of the mouth, and which we have here figured. Inside the mouth of the bottle is a rim of cork about an inch in depth, and an eighth of an inch in thickness, into which is inserted a stout, solid, plug-shaped glass stopper, the top of which is flattened and made of exactly the same diameter as the neck of the bottle. This, when put well in, is kept tight by means of the cork-rim, yet not so much as to prevent its being easily extracted. When full they may be covered over with moistened bladder, or better, by putting on a slip of thin sheet Vulcanized India-rubber, which is made to adhere by the previous application of a little "Caoutchouc-varnish" along the edges, and further secured by a piece of twine. Bottles of this construction could be made with the mouths of any convenient size, and would form excellent travelling companions.

16. A quantity of *twine*, some *thread*, and a *pocket measuring-tape.*

17. One or two pairs of *scissors.*

18. When it is intended to transmit living plants *Ward's plant-cases*, which are simply miniature green-houses, must be procured.

General Directions for Dry Specimens.

1. *Selection of Specimens, &c.*—Whenever it is pos-

sible, specimens should be gathered in fine weather. If not too large, the whole plant should be taken; but if otherwise, attention should be paid to preserve all the characteristic parts. Roots should be carefully washed: if the root-leaves or lower stem-leaves differ much from the upper leaves, the former should be kept with the root or lower portion of the stem. Flowers and fruit should, if practicable, both be retained; and in Monoeciousand Dioecious plants both male and female flowers are requisite; in some, as in many *Salicaceæ*, the young shoot, with its fully developed leaves, are desirable. Bad specimens should not be kept, even as duplicates, unless the plant is a rare one. In short, the rule should be, to bring away as much as can conveniently be managed, and in as perfect a condition as circumstances will permit.

2. *Size and Carriage of Specimens.*—In general no specimens should exceed 16 inches in length by 9½ inches in breadth; when under this size, the root should be kept attached. Many Grasses, Sedges, and slender Ferns, which should be kept entire, may, when longer than this, be preserved by folding them once or twice backwards and forwards, according to their dimensions. In collecting *Filices*, two fronds are required to make one complete specimen. Where roots cannot be easily obtained, the stem should be separated below the insertion of the root-leaves. When plants are gathered they should be retained in the hand as short a time as possible, but should be immediately placed in the vasculum, a small slip of

paper mentioning the locality being attached; this is especially requisite in warm countries, as plants begin to fade very rapidly, and their value as specimens is thereby much deteriorated. If the heat is very great, it is advisable to line the inside of the collecting-box with large leaves, and from time to time to sprinkle a little water on its contents. Deciduous flowers, or those with fugitive colours, should be placed at once in the "Field Book."

3. *Drying.*—The different apparatus being placed at hand take a plant from the vasculum, and opening one of the fasciculi of drying-paper place it within the centre sheet, with the root or lower part downwards, and proceed to lay it out, not displaying the parts artificially, but, as far as can be, retaining its natural form and appearance. This must then be placed under pressure between the boards, and after every ten or twelve such parcels one of the thin boards should intervene. When plants are likely to adhere to the drying-paper they should be laid out in a sheet of tea-paper, which should then be placed within the absorbent-paper. After an interval of from twelve hours to two days the plants should be removed into dry paper, and the damp sheets hung up to dry. This process must be repeated twice or thrice until the specimens are thoroughly dried, when they may be transferred, with a piece of paper mentioning all particulars, or better, with a number referring to an entry in the note-book, into a sheet of common gray paper, and be laid aside.

4. *Points of inquiry.*—These should comprehend

the nature and size of the plant, its native name, the date, locality, soil, geological formation, elevation above the level of sea, its ascertained properties and uses, also the colour of the recent flowers, if odorous, &c.

5. *Rules for particular plants.*—Specimens collected in moist situations, or in damp weather, and water-plants should be freed from external moisture before being laid out. Succulent plants require long continued pressure. Sometimes they are scarified to facilitate the escape of the juices, at others they are plunged for a moment into hot water before being pressed. *Orchidaceæ* should be laid out in warm paper and dried rapidly. Many Heaths and Pines, and other plants with fine rigid leaves require to be *killed* by being plunged for an instant into boiling water. *Mosses* should be selected in fructification; they may be gathered in tufts, which, if dried by gentle pressure, can afterwards be separated, moistened, and again dried. Fleshy *Fungi* are best kept in spirits; some of the smaller species may be occasionally dried entire, by having holes pierced in them by fine pins, and then being exposed to a warm dry atmosphere; others, as many *Agarici* are prepared by taking a thin slice "from the centre, extending from the top of the pileus to the base of the stipe," which portion is dried separately; "the inner cellular portion of the pileus and stipe is then removed, and these parts are dried so as to give the form." Such *Lichens* as admit of pressure may be treated like mosses; when closely encrusting rocks,

stones, old wood, trunks of trees, &c., a portion of the material on which they grow must be kept with them, and each specimen be separately wrapped up in soft paper. Minute specimens of *Cryptogamia* may be dried at once, and placed on white paper with a little gum-tragacanth mucilage. Marine *Algæ* are collected along the sea-shore, especially after a storm, but are more abundantly procured by dredging, or by closely examining nets, fishing lines, &c., when hauled up; fine varieties should be kept in a bottle of sea-water until prepared. Fresh-water *Algæ* are obtained by searching ponds, lakes, streams, &c. Marine species are most easily and most quickly prepared for transmission, by drying them quickly and thoroughly, *without previously washing them*, and then packing them loosely in bags or boxes. Small and delicate specimens must, however, be put up at once. This is effected by washing them first in salt water, next in a little fresh water, and then also in fresh water floating them one by one in a shallow-dish; under the specimen a piece of white paper is now introduced, and carefully raised to the surface; then, with any pointed instrument, display the various parts, remove it from the water, complete the setting out, place it between folds of bibulous paper, and proceed as for other plants; a piece of calico laid over the specimens will prevent their sticking to the paper. *Corallines* should be roughly dried, like the larger sea-weeds.

Parasitical Cryptogamic plants should be preserved adherent upon a portion of the substance on which they exist.

Varieties should be always carefully kept, nor should monstrosities or abnormal deviations be disregarded.

Directions for Moist Specimens.

Flowers, leaves, many fruits, fleshy roots, various parasites, and some Fungi are at times preferably preserved moist. For this purpose many fluids have at different periods been employed. None is more certain in its effect than alcohol, but it labours under the disadvantage of usually changing the colours to a nearly uniform brown; it is, nevertheless, the best preservative for subjects kept for minute dissection. Acetic acid, diluted to the density of 1008, answers well for a limited period, as does also sometimes a solution of kreosote. Professor Christison recommends a saturated solution of common salt, made with the aid of a boiling heat, as more generally applicable than any other antiseptic, and especially for purposes of transmission it is very serviceable. Pulpy fruits, such as those of the *Citraceæ,* must be immersed in diluted acetic acid. The bottles we have already alluded to will answer exceedingly well for such purposes, or, when the objects are larger, earthen jars, which should have first a cover or stopper of the same material, and then have a piece of thin vulcanized caoutchouc secured over all. In this manner large Orchids, flowering branches of Palms, or the large flowers of the gigantic *Victoria regia,* may be safely kept. From some trials we have lately made, turpentine seems to answer as a preservative for some delicate *Fungi.*

Directions for Living Plants.

1. *Entire Plants.*—These can generally be successfully transported only in "Wardian cases," in which they should be placed some days before being fastened down, and then well watered. Some small Cactuses, Aloes, Orchids, and various epiphytes may be transmitted by being removed by the roots, and packed in boxes with paper or straw.

2. *Cuttings.*—Certain plants only can be thus propagated, such as many Cactuses, Aloes, Sponges, Fig-marigolds, Pine-apples, &c. Cuttings should be removed at an articulation, the wound dried in the sun, and they should then be packed in boxes with paper.

3. *Seeds and Fruits.*—Seeds should be gathered when quite ripe, and preserved, if possible, in the entire seed-vessel. Pine-cones should be tied round with a little thread to prevent the escape of the seeds from the bursting of the valves. Seeds should be made up in parcels, with brown or cartridge-paper, and kept in airy, well ventilated places. De Candolle advises seeds, gathered in a moist season or country, to be packed in charcoal. Large and oily seeds, as those of the Tea and Coffee plants, also those of various Laurels and Myrtles, must be placed in sandy earth; boxes may be packed up containing alternate layers of earth and seeds, pressed closely together.

4. *Bulbs, Tubers, and Rhizomes.*—These should be procured when the foliage has withered, be well

dried, and then packed in boxes with dry moss, sand, peat-mould, or saw-dust.

Directions for Vegetable Productions.

1. *Woods.*—Specimens should be procured whenever practicable, especially of such as seem adapted for economical purposes. They should be portions of branches, or sections of trunks, and should not be too small.

2. *Gums and Resins.*—The plants whence procured, specimens of different varieties, or in various stages, should be sought after, also noting native names, method of preparation or collection, mode of transmission, &c.

3. *Dye-stuffs.*—As for the last, carefully inquiring after such as are in use by natives, but are not commercial.

4. *Medicinal-agents* present a wide field for investigation, as the true sources of many drugs in every day use are still matters of obscurity, such are various Catechus and Kinos, Cassia-buds, Rhubarb, Socotrine-Aloes, Balsams of Peru and Tolu, many varieties of *Cinchona*, &c.

6. *General commercial, and other products.*—Examples of which are innumerable, and to be met with everywhere, yet many are of exceeding interest and importance.

6. *Vegetable-poisons*, especially those used by savage tribes for poisoning their spears and arrows, ought always to be investigated. Many most virulent substances are as yet but barely known; one

of these, the "Ordeal Bean," of the old Calabar, the fruit of one of the *Fabaceæ* has been lately received and examined by Dr. Christison.

All dried specimens should be packed with camphor, to keep off attacks of insects, and should be placed during transmission in cool, dry places. Living specimens require to be kept in dry, airy situations. When specimens cannot be brought away, or if they are likely to lose their natural form during transmission, accurate drawings should be made, the tints also of colours which alter much in drying, should be shaded in. When objects are too bulky, such as trunks and branches of large trees, their dimensions should be measured and carefully noted.

III.—GEOLOGY AND MINERALOGY.

The Geologist or Mineralogist, before setting forth on his travels, should furnish himself with the following articles:

1. *Hammers.*—A large one, of about two pounds weight, compressed in form, both extremities wedge-shaped, the one end being sharp-edged longitudinally, and the other end truncate; also a small one, of which the sharp edge may be horizontal, for trimming specimens.

2. *Iron chisels,* of these three or four should be provided, about 7 inches in length, like those used by stone-cutters.

3. A set of *small boring instruments.*

4. *A small pickaxe*, for fossils.

5. *A stout jack-knife* and *a file*, for ascertaining the streak and hardness.

6. *A pocket lens*, with two or three glasses.

7. *A bag* for carrying specimens, of stout, flexible leather, in shape resembling a game-bag.

8. *An accurately graduated compass.*

9. *A klinometer*, that of Prof. Henslow is one of the most simple.

10. *A portable level.*

11. *A mountain-barometer*, or *a sympiesometer.*

12. *A magnet.*

13. *A chemical test-chest.*—These are now kept, ready-fitted, by some chemists and philosophical-instrument dealers in the principal cities ; but for those who cannot procure such, or who are desirous of making one up themselves, we shall enumerate the various necessary apparatus and re-agents, which can easily, by a little ingenuity, be adapted to any portable chest. This we are the more inclined to do, as we would recommend a somewhat larger and more extended set than is usually prepared, so that the traveller may be enabled to make rough analyses of soils, or a general qualitative examination of mineral springs.

I.—APPARATUS.

1. Small scales and weights ; 2, an agate pestle and mortar ; 3, a platinum crucible with ground cover ; 4, a platinum spoon ; 5, platinum wire and holder ; 6, fine-pointed forceps tipped with platinum ; 7, small porcelain capsules ; 8, test-tubes (of German glass) ; 9, a pipette ; 10, some glass rods ; 11, a small graduated measure ; 12,

small filtering funnel; 13, filtering-paper; 14, a mouth blow-pipe; 15, a spirit lamp and wick; 16, density-beads; 17, charcoal, for supporting ores before the blow-pipe; 18, pieces of copper and iron-wire.

II.—CHEMICAL-AGENTS.

1, Carbonate of soda, as a flux; 2, biborate of soda (borax), as a flux; 3, phosphate of soda and ammonia (microcosmic salt), as a flux; 4, nitrate of potassa (saltpetre), as an oxidizing agent; 5, borax-glass, for the determination of phosphoric acid; 6, solution of nitrate of cobalt, to distinguish alumina, magnesia, and oxide of zinc; 7, oxide of copper, for determining small quantities of chlorine; 8, fluoride of calcium (fluor-spar), to recognise lithia and boracic acid; 9, metallic lead; and 10, bone-ashes, for separating silver from some of its ores; 11, sulphuric acid, as a solvent for detecting baryta, strontia, and lead, &c.; 12, nitric acid, as a solvent, and an oxidizing agent; 13, hydrochloric (muriatic) acid, as a solvent, for detecting oxides of lead and silver, protoxide of mercury, free ammonia, &c.; 14, ammonia, as an alkaline agent, and a solvent; 15, solution of sulphuret of ammonium (hydrosulphuret of ammonia), for distinguishing various solutions by precipitation; 16, solution of nitrate of baryta, to detect sulphates; 17, solution of oxalate of ammonia, to detect calcia (lime); 18, solution of nitrate of silver, to distinguish chlorides; 16, solution of calcia (lime-water), to precipitate carbonates; 20, solution of ferrocyanide of potassium, to detect oxide of copper and peroxide of iron; 21, solution of acetate of lead, to distinguish hydrosulphuric acid (sulphuretted-hydrogen); 22, alcohol; 23, test-papers, blue and red litmus, or turmeric and Georgina papers.

These substances should all be kept in bottles, of which those containing fluids, or substances acted on by exposure, should have glass stoppers; and those with acids or caustic alkalies should likewise be capped. Phials of from one to two ounces will supply abundant materials for numerous miniature analyses. This list comprises every thing requisite for a general examination of rocks and soils, or for testing mineral springs. A few other properties of minerals may be attended to, as the streak, hardness, fusibility, colour, transparency, fracture, &c., but the study of their other physical and optical qualities must be reserved for the return home.

For travelling purposes, collections of type minerals for illustrating different properties, are now prepared. Among the more useful are sets exhibiting degrees of hardness, fusibility, and cleavage, which can be procured at a very reasonable rate from Mr. S. Highley, 32, Fleet-street, London, where may likewise be obtained models in wood or glass illustrative of crystallographic forms, and shewing the principal geometric shapes assumed by simple minerals.

Isolated specimens of rocks are of little or no value, while, on the other hand, series of examples are highly instructive and important. It is of very great consequence that the locality be known, therefore the collections of one day should not be allowed to interfere with those of the next, but should be carefully labelled and packed up on the same evening. Specimens should not be too small, those of rocks should be about two or three inches square, but when any gems or precious minerals are discovered, they should always be secured irrespective of size. With regard to fossil remains, however, the case is quite different, as every fragment should be secured, as most valuable to science, species and genera having been established on almost a single bone.

Being in a state of decay should not preclude an attempt at least to bring away the parts, as by various processes, such as those mentioned by the late Dr. Mantell, in his "Medals of Creation," renewed stability and firmness may be given to bones which, when first discovered, will scarcely bear being touched. Not merely should actual remains of plants and animals be enquired for, but the marks of footsteps, &c., of the latter, or impressions of the former, should be sought after and carefully recorded, and when practicable, casts should be taken of these most interesting tokens. Thus, long before the discovery of the actual remains of the *Labyrinthodon*, its existence was inferred and demonstrated from an examination of its footsteps indelibly impressed on the New Red-Sandstone.

All traces of man should be most carefully attended to, as being of more than ordinary interest.

Mineralogical specimens should be wrapped, first in fine paper, then in cotton or tow, and lastly in stout paper. Mineral-waters should be preserved in bottles completely filled, and carefully covered to prevent the access of atmospheric air. Fossils should be packed with some soft material, attention being paid to keep together fragments of the same bone in one spot.

Geology is a science the study of which may be commenced practically with but little previous reading. Mineralogy and Palæontology, again, require much patient consideration and enquiry, and for the successful cultivation of the former, considerable chemical and mathematical knowledge are necessary. For those who wish to pursue these subjects, the best works in English are, "Lyell's Principles of Geology," Sir H. De la Beche's "How to observe; Geology," Ansted's "Elementary Course of Geology, &c.," Mantell's "Medals of Creation," Richardson's "Geology," Dana's "Mineralogy;" and for an acquaintance with the principles of chemical analysis, Bullock's translation of Fresenius's "Chemical Analysis."

IV. METEOROLOGY.

Although we have been precluded by the length to which this volume has already extended, from treating of Meteorology somewhat in detail, still it may prove of service if we simply mention the preparations which ought to be made by any traveller desirous of attending to this very important branch of science, and give some indications of the chief points to which his attention should be directed. The meaning of the term is frequently misunderstood, thereby frequently preventing its full value from being appreciated; it is by many looked upon as merely the study of aerial curiosities, whereas, it strictly comprehends an enquiry into the nature, the changes, and the influences exerted by, or upon, our atmosphere; including, amongst its varied topics, the winds, rain, hail, snow, and electrical phenomena, as well as all those appearances in the heavens, of more or less frequent occurrence, such as the rainbow, waterspout, halos, mock-suns by day, or the fleeting aurora by night.

The instruments and apparatus which will be requisite for such enquiries, are,—

1. *A Barometer.*—A portable one is the most generally useful, but where it can be managed it is advisable to carry also a standard one for comparison. The lately invented "Aneroid Barometer" is, for many purposes, very appropriate; it bears carriage well, and is not injured by being shaken; it is also extremely sensitive, more so than the mercurial instrument; we have ourselves frequently watched the index falling as a squall or heavy cloud was passing overhead, and rising immediately afterwards, indeed a good one will distinctly indicate the difference in the atmospherical pressure for every altitude of eight or ten feet; we have seen the height of mountains varying from 3000 to 4000 feet, ascertained by its means, and its correctness afterwards checked by trigonometrical measurement.

2. *Thermometers.*—Of these, several should be provided. One, well tested and minutely graduated, should be carefully kept for comparison; metallic frames are preferable to wooden ones, as the latter warp. One thermometer, for ascertaining the temperature of fluids, should have the bulb projecting an inch and-a-half beyond the foot of the scale, and be carefully packed up in a soft padded case. For very cold climates alcohol must be used instead of

mercury. The most convenient register-thermometer is that of Sykes, in which the extremes of heat and cold are recorded by a single instrument.

3. *Hygrometer.*—One of the most delicate is the instrument usually known as the "Wet and dry bulb thermometer," which, being rather fragile, must be carried in a soft padded, carefully adapted case.

4. *A good Compass.*

Other apparatus, &c. may be added according to opportunity or inclination, such as the "Anemometer," for calculating the force of the wind; the "Actinometer," for studying solar radiation; a "Rain-guage," for measuring the fall of rain; a "Cyanometer," for estimating the depth of blue colour of the skies; or, where circumstances permit, and previous acquaintance qualify, "Magnetical Instruments."

The most important point to be attended to is *daily general observation*, carefully entering in the columns of a register particulars of the following items, viz.: Pressure, Temperature, Moisture, Wind (direction and force), Weather, Clouds, Rain, and other observations as may be necessary. The proper hours for daily observation are 3 A.M., 9 A.M., 3 P.M., and 9 P.M.; and, where it can be managed, two additional hours should be added, namely, 6 A.M. and 6 P.M. Occasional hourly observations should be made, for which purpose Sir J. Herschell recommends the 21st of each month to be appropriated, or at least in the months of March, June, September, and December. The great things, however, to be kept in view, are regularity and accuracy. *Occa-*

sional observations include notice of such phenomena as are not of regular occurrence, such as unusual barometric disturbance, electric storms and other appearances, squalls, hurricanes, hail-storms, fogs, water-spouts, halos, mock-suns, zodiacal light, the aurora, shooting stars, meteors, &c. Should it be the lot of the traveller to encounter one of those terrible circular storms, named "Cyclones," he should carefully note his position, the direction of wind, or any sudden changes which may occur, on which points much information may be obtained from the works of Colonel Reid or Mr. Piddington.

IN conclusion, there are several instruments and tools which, if provided, may very probably be found of extreme service to the travelling naturalist, among which we would particularly mention the "Microscope," as being nearly indispensable. Those we especially recommend are made by Oberhäuse, of Paris, and they excel all others in portability, cheapness, and general efficiency. One magnifying from 30 to 450 diameters may be obtained for £5 in France, or about £6 in this country; these contain three eye-pieces, two or three object-glasses, and a micrometer, which, with the stand, &c., are packed in a box 8¾ in. long, 5 in. broad, and 3½ in. deep. It is a pity that this maker does not establish an agency in Britain, as his microscopes are now much employed here, and are excelled by none in the facility of their application, or the correctness of their revelations. Another very essential addendum is a pocket-telescope, which is mostly conveniently and safely carried in a leather case, slung over the shoulder. A few simple carpenter's tools, such as a hammer, saw, chisel, gimlet, and a few nails, will often be found of great value. Among other miscellanea are balls of twine of different sizes, thread, a box of colours, stationery, and finally an apparatus for instantaneous light, which last will often add much to the comfort of the wanderer. The most certain plan is by a flint and steel with German tinder, but we have ourselves found the matches made by R. Bell, 16, Basing-lane, or by Bell and Black, 15, Bow-lane, Cheapside, London, and which appear to be tipped with a composition containing chlorate of potassa, to resist damp well, and to be fit for service long after all other forms of Congreves and Lucifers had become quite useless.

THE END.

T. E. METCALF, Printer, 63, Snow Hill, London.

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ADDENDUM.

While this work has been passing through the press, the following Sub-Order of Gasteropodous Pectinibranchs has been proposed by Dr. Gray to embrace the family of the Cones (*Conidæ*), and possibly also the Fissure-shells (*Turridæ*).

SUB-ORDER.—TOXIFEROUS-PECTINIBRANCHS (Toxifera).

Head with a tubular expansion of the veil between the tentacles; proboscis retractile, furnished with a fleshy tube, having a bundle of subulate barbed teeth at the end, instead of the usual lingual riband. Carnivorous.

1557

Shakspeare's Marriage.

The gleanings of tradition excepted, the first knowledge that has reached us of the poet, after his baptism, has reference to his marriage. Rowe states that ‘he thought fit to marry while he was yet very young,’ and that his wife was the daughter of one Hathaway, said to have been a substantial yeoman in the neighborhood of Stratford; and later disclosures prove that Rowe must of had access to good sources of information. The marriage took place in the fall of 1582, when the poet was in his nineteenth year. On the twenty-eight of November, that year, Fulk Sandels and John Richardson subscribed a bond whereby they became liable in the sum of forty pounds sterling, to be forfeited to the Bishop of Worcester, in case there should be found any lawful impediment to the marriage of William Shakspeare and Anne Hathaway, of Stratford; the object being to procure such a dispensation from the Bishop as would authorize the ceremony after once publishing the bans. The original bond is preserved at Worcester, with the marks and seals of the two bondsmen affixed, and also bearing a seal with the initials R. H., as to show that the bride's father, Richard Hathaway, was also present and consented to the act.

The parish books all about Stratford and Worcestor have been ransacked, but no registry of the marriage has been discovered. The probabilty seems to be, that the ceremony took place in one of the neighboring parishes, perhaps Weston, or Billesday, or Luddington, where the registers of that period have not been preserved. Anne Hathaway was of Shottery, a pleasant village situated within an easy walk of Stratford, and belonging to the same parish. No registry of her babtism has come to light; but the baptismal register of Stratford did not commence till 1558. She died on the sixth of August, 1623, and the inscription on her monument informs us that she was sixty-seven years of age. Her birth therefore, must have occurred in 1556, eight years before that of her husband.

LF, 63, SNOW HILL.

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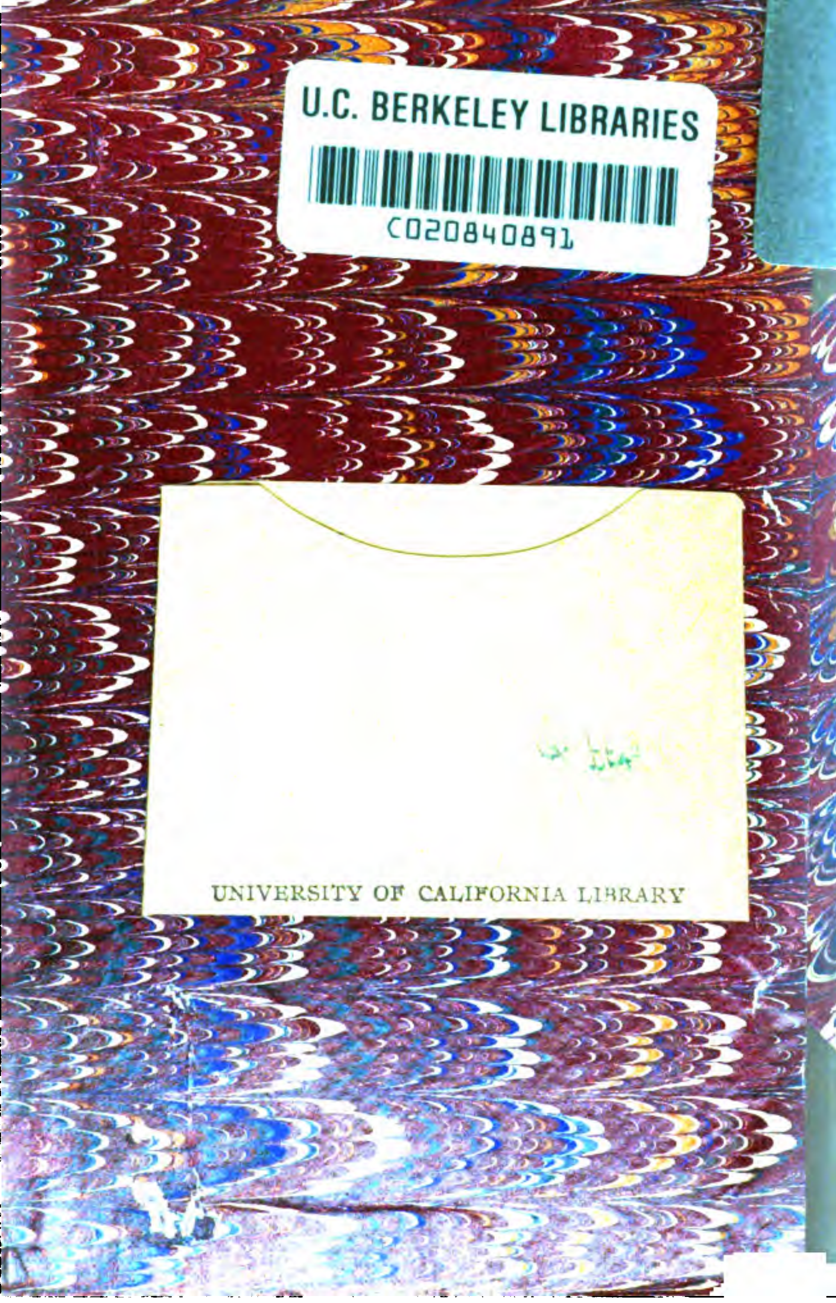

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